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RESOURCE CONSERVATION AND RECOVERY ACT FACILITY INVESTIGATION REPORT
ZONE I VOLUME II OF VII SECTION 10 CNC CHARLESTON SC
3/1/1999
ENSAFE

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY
CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA
CTO-029

ZONE I
RCRA FACILITY INVESTIGATION REPORT

VOLUME II OF VII
SECTION 10

SOUTHDIV CONTRACT
NUMBER: N62467-89-D-0318

Prepared for:

DEPARTMENT OF THE NAVY
SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
NORTH CHARLESTON, SOUTH CAROLINA

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10.1 AOC 671, Metering House, (Former Building 3905G)

AOC 671 is a former metering house, Building 3905G, and two associated 25,000-gallon concrete USTs. The metering house and tanks were constructed in 1944 and used to store aviation gasoline until 1966. The area is currently an unused asphalt parking lot between Piers Q and R. Two raised circular areas in the asphalt are thought to represent the locations of the USTs. The lack of information documenting removal of these USTs and the surface expression suggest that the USTs are still in place. A concrete foundation along Hobson Avenue is all that remains of Building 3905G. No previous investigations or remedial actions have been documented for AOC 671.

Materials of concern identified in the approved final RFI work plan include VOCs, petroleum hydrocarbons, and heavy metals. Potential receptors include current or future site workers who may be involved in invasive activities that might bring them in direct contact with subsurface contaminants. The ecology of the Cooper River is also a potential receptor.

To fulfill the CSI objectives and confirm the presence of any contamination from onsite activities, soil and groundwater were sampled in accordance with the final RFI work plan and Section 3 of this report. In addition to the proposed soil samples, two additional borings were advanced to help define the extent of PCBs/pesticides in site soils.

10.1.1 Soil Sampling and Analysis

Soil was sampled in two rounds at AOC 671 at locations shown on Figure 10.1.1. The final RFI work plan proposed advancing eight soil borings during the initial sampling and collecting samples from both the upper and lower-intervals. Eight proposed upper-interval samples and seven of the eight proposed lower-interval samples were collected. The lower-interval sample from location 671SB003 was not collected because the water table was encountered at less than 5 feet bgs. All first-round samples were analyzed at DQO Level III for VOCs, SVOCs, pesticides/PCBs, cyanide, and metals. Two samples selected as duplicates were analyzed at DQO Level IV for Appendix IX analytical parameters. Four first-round soil borings (upper and lower-intervals) were analyzed for organotins. Two additional second-round samples were collected to determine the extent of pesticides detected in the initial sampling. Table 10.1.1 summarizes the two rounds of soil sampling.

Grid-based soil boring (GDISB017) was advanced in the AOC 671 area as shown in Figure 10.1.1. Upper and lower-interval samples from this boring were analyzed for the standard suite of parameters. Results of these analyses are presented in the nature and extent discussion of AOC 671 and presented in Appendix D.

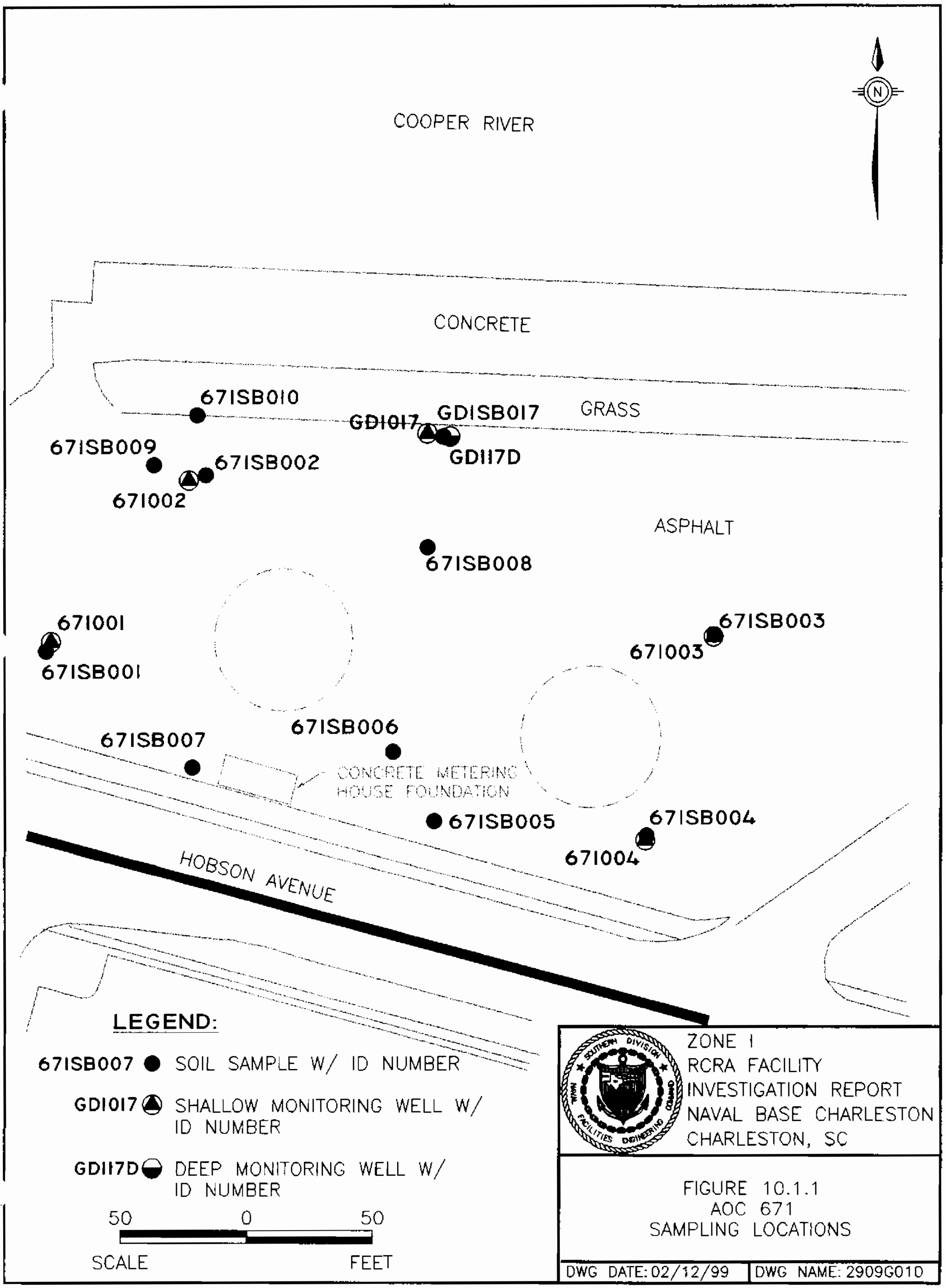
10.1.2 Nature and Extent of Contamination in Soil

Organic compound analytical data for soil are summarized in Table 10.1.2. Inorganic analytical data for soil are summarized in Table 10.1.3. Table 10.1.4 summarizes all analytes detected in soil at AOC 671. Appendix D contains the complete analytical data report for all samples collected in Zone I.

Volatile Organic Compounds in Soil

Three VOCs were detected in surface soil at AOC 671, but at concentrations far below their RBCs: acetone, acetonitrile, and toluene. Acetone and toluene were also detected in subsurface soil also at concentrations far below their respective SSLs.

The VOCs acetone and toluene were detected in surface soil at grid soil boring GDISB017. Acetone was detected in surface soil sample GDISB01701 at 62 μg/kg and toluene was detected in this sample at 3 μg/kg.



ZONE I
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NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.1.1
AOC 671
SAMPLING LOCATIONS

DWG DATE: 02/12/99 | DWG NAME: 2909G010

Table 10.1.1
AOC 671
Soil Sampling Summary

Sampling Round	Sampling Date	Samples Collected	Sample Analyses	Comments
1	02/20/95 02/21/95 02/27/95	Upper - 8 (8)	Standard Suite Organotins	Organotins were analyzed on four upper-interval samples (671SB00501 through 671SB00801) for site characterization.
		Lower - 7 (8)	Standard Suite, Organotins	One lower-interval sample (671SB00302) was not collected due to a water table less than 5 feet bgs. Organotins were analyzed on four lower-interval samples (671SB00502 through 671SB00802) for site characterization.
		Duplicate - 2	Appendix IX	671CB00201/671CB00501
2	06/21/95 09/19/95	Upper - 2 Upper - 1	Pesticides and PCBs Physical Parameters	Physical parameters collected at boring location 671SB00201.

Notes:
( ) = Parentheses indicate number of samples proposed.
Standard Suite = VOCs, SVOCs, metals, cyanide, pesticides, and PCBs at DQO Level III.
Appendix IX = Standard suite, plus hex-chrome, dioxins, herbicides, and OP pesticides at DQO Level IV.
Physical parameters analyses included CEC, chloride, sulfur, ammonia, nitrate/nitrite, phosphorus, TOC and total moisture.

Table 10.1.2
AOC 671
Organic Compound Analytical Results for Soil (μg/kg)

Parameters	Sample Interval	Detection Frequency	Detection Range	Mean	RBC (upper) SSL (lower)	Number of Samples Exceeding RBC or SSL
Volatile Organic Compounds						
Acetone	Upper	3/8	21.0 - 31.0	26.7	780,000	0
	Lower	2/7	33.0 - 36.0	34.5	8,000	0
Acetonitrile	Upper	1/8	130	130	47,000	0
	Lower	0/7	ND	ND	440	0
Toluene	Upper	5/8	2.0 - 13.0	4.7	1,600,000	0
	Lower	4/7	2.0 - 12.0	5.8	6,000	0
Semivolatile Organic Compounds						
BEQs	Upper	1/8	1,088	1,088	87	1
	Lower	0/7	NA	NA	NA	NA
Benzo(a)anthracene	Upper	1/8	1,600	1,600	870	1
	Lower	0/7	ND	ND	800	0

Table 10.1.2
AOC 671
Organic Compound Analytical Results for Soil (μg/kg)

Parameters	Sample Interval	Detection Frequency	Detection Range	Mean	RBC (upper) SSL (lower)	Number of Samples Exceeding RBC or SSL
Benzo(a)pyrene	Upper	1/8	690	690	87	1
	Lower	0/7	ND	ND	4,000	0
Benzo(b)fluoranthene	Upper	1/8	1,270	1,270	870	1
	Lower	0/7	ND	ND	2,500	0
Benzo(k)fluoranthene	Upper	1/8	1,420	1,420	8,700	0
	Lower	0/7	ND	ND	25,000	0
Chrysene	Upper	1/8	1,305	1,305	87,000	0
	Lower	0/7	ND	ND	80,000	0
Dibenz(a,h)anthracene	Upper	1/8	70.0	70.0	87	0
	Lower	0/7	ND	ND	800	0
Indeno(1,2,3-cd)pyrene	Upper	1/8	260	260	870	0
	Lower	0/7	ND	ND	7,000	0
Acenaphthene	Upper	1/8	975	975	470,000	0
	Lower	0/7	ND	ND	290,000	0
Anthracene	Upper	1/8	3,020	3,020	2,300,000	0
	Lower	0/7	ND	ND	5,900,000	0
Benzo(g,h,i)perylene	Upper	1/8	235	235	310,000	0
	Lower	0/7	ND	ND	1.2E+08	0
bis(2-Ethylhexyl)phthalate (BEHP)	Upper	0/8	ND	ND	46,000	0
	Lower	1/7	76.0	76.0	1,800,000	0
Di-n-butylphthalate	Upper	3/8	98.0 - 230	143	780,000	0
	Lower	3/7	51.0 - 130	92.3	2,300,000	0
Dibenzofuran	Upper	1/8	1,225	1,225	31,000	0
	Lower	0/7	ND	ND	68,000	0
Fluoranthene	Upper	3/8	38.0 - 6,400	2,170	310,000	0
	Lower	1/7	110	110	2,100,000	0
Fluorene	Upper	1/8	2,160	2,160	310,000	0
	Lower	0/7	ND	ND	280,000	0
1-Methylnaphthalene	Upper	1/8	110	110	310,000	0
	Lower	0/7	ND	NA	72,000	0
2-Methylnaphthalene	Upper	1/8	58.0	58.0	310,000	0
	Lower	0/7	ND	ND	230,000	0
Naphthalene	Upper	1/8	59.0	59.0	310,000	0
	Lower	0/7	ND	ND	42,000	0

Table 10.1.2
AOC 671
Organic Compound Analytical Results for Soil (μg/kg)

Parameters	Sample Interval	Detection Frequency	Detection Range	Mean	RBC (upper) SSL (lower)	Number of Samples Exceeding RBC or SSL
N-Nitrosodimethylamine	Upper	0/8	ND	ND	13.0	0
	Lower	1/7	52.0	52.0	0.0026	1
n-Nitroso-di-n-propylamine	Upper	1/8	340	340	91	1
	Lower	0/7	ND	ND	0.023	0
Phenanthrene	Upper	1/8	8,900	8,900	230,000	0
	Lower	0/7	ND	ND	660,000	0
Pyrene	Upper	2/8	57.0 - 4,300	2,180	230,000	0
	Lower	1/7	71.0	71.0	2,100,000	0
Pesticides/PCBs						
4,4'-DDD	Upper	6/10	4.8 - 430	86.4	2,700	0
	Lower	2/7	19.0 - 60.0	39.5	8,000	0
4,4'-DDE	Upper	5/10	120 - 490	278	1,900	0
	Lower	2/7	11.0 - 160	85.5	27,000	0
4,4'-DDT	Upper	3/10	9.5 - 21.0	15.5	1,900	0
	Lower	0/7	ND	ND	16,000	0
Dieldrin	Upper	2/10	0.19 - 4.6	2.4	40	0
	Lower	0/7	ND	ND	2	0
Endosulfan I	Upper	2/10	1.9 - 2.6	2.3	47,000	0
	Lower	0/7	ND	ND	9,000	0
Endosulfan sulfate	Upper	2/10	0.33 - 0.55	0.44	47,000	0
	Lower	0/7	ND	ND	4,600	0
Endrin	Upper	2/10	0.14 - 2.7	1.4	2,300	0
	Lower	0/7	ND	ND	500	0
Endrin aldehyde	Upper	3/10	0.78 - 2.1	1.5	2,300	0
	Lower	2/7	1.8 - 16.0	8.9	340	0
Heptachlor epoxide	Upper	2/10	7.9 - 8.7	8.3	70	0
	Lower	0/7	ND	ND	330	0
alpha-BHC	Upper	1/10	0.17	0.17	100	0
	Lower	0/7	ND	ND	0.25	0
beta-BHC	Upper	1/10	20.0	20.0	350	0
	Lower	0/7	ND	ND	1.3	0
delta-BHC	Upper	1/10	0.59	0.59	350	0
	Lower	0/7	ND	ND	1.8	0

Table 10.1.2
AOC 671
Organic Compound Analytical Results for Soil (μg/kg)

Parameters	Sample Interval	Detection Frequency	Detection Range	Mean	RBC (upper) SSL (lower)	Number of Samples Exceeding RBC or SSL
Dioxin Compounds and Organotins						
TEQs	Upper	2/2	2.13E-04 - 2.10E-03	1.16E-03	4.3E-03	0
	Lower	0/0	NA	NA	1.6	0
123789-HxCDD	Upper	1/2	2.41E-03	2.41E-03	0.043	0
	Lower	0/0	NA	NA	4.1	0
1234678-HpCDD	Upper	2/2	0.0113 - 0.022	0.0166	0.430	0
	Lower	0/0	NA	NA	108	0
OCDD	Upper	2/2	0.083 - 0.259	0.171	4.30	0
	Lower	0/0	NA	NA	1,080	0
123478-HxCDF	Upper	1/2	3.5E-03	3.5E-03	0.043	0
	Lower	0/0	NA	NA	216	0
123678-HxCDF	Upper	1/2	2.76E-03	2.76E-03	0.043	0
	Lower	0/0	NA	NA	216	0
123789-HxCDF	Upper	1/2	4.74E-03	4.74E-03	0.043	0
	Lower	0/0	NA	NA	216	0
234678-HxCDF	Upper	1/2	1.87E-03	1.87E-03	0.043	0
	Lower	0/0	NA	NA	216	0
1234678-HpCDF	Upper	2/2	1.48E-03 - 8.34E-03	4.91E-03	0.430	0
	Lower	0/0	NA	NA	54	0
OCDF	Upper	2/2	2.86E-03 - 0.0119	7.40E-03	4.30	0
	Lower	0/0	NA	NA	540	0
Tetrabutyltin	Upper	3/4	5.88 - 117.2	49.31	2,300	0
	Lower	2/4	3.20 - 92.01	47.61	NL	0

Notes:
NA = Not Applicable/Not Available/Not Analyzed
ND = Not Detected/Not Determined
NL = Not Listed
μg/kg = micrograms per kilogram
See Table 5.5 for organic compound screening concentrations and their sources.

Table 10.1.3
AOC 671
Inorganic Analytical Results for Soil (mg/kg)

Parameters	Sample Interval	Detection Frequency	Detection Range	Mean	Background Concentration	RBC (upper) SSL (lower)	Number of Samples Exceeding: RBC and Background (upper) or SSL and Background (lower)
Aluminum (Al)	Upper	8/8	3,870 - 12,900	7810	27,400	7,800	0
	Lower	7/7	4,570 - 13,600	8360	18,900	560,000	0
Antimony (Sb)	Upper	0/8	ND	ND	NL	3.1	0
	Lower	1/7	6.2	6.2	NL	2.7	1
Arsenic (As)	Upper	7/8	1.5 - 8.3	5.5	21.6	0.43	0
	Lower	4/7	2.3 - 6.3	4.3	6.45	15	0
Barium (Ba)	Upper	8/8	10.2 - 20.8	15.7	54.2	550	0
	Lower	7/7	7.1 - 37.1	15.7	36	820	0
Beryllium (Be)	Upper	4/8	0.34 - 0.72	0.46	0.95	16	0
	Lower	3/7	0.39 - 0.86	0.62	0.67	32	0
Calcium (Ca)	Upper	8/8	7,150 - 45,800	23,200	NL	NL	NA
	Lower	7/7	3,960 - 68,200	16,800	NL	NL	NA
Cadmium (Cd)	Upper	1/8	0.50	0.50	0.61	7.8	0
	Lower	0/7	ND	ND	0.54	4.0	0
Chromium (total) (Cr)	Upper	8/8	10.6 - 22.7	17.5	34.5	39	0
	Lower	7/7	9.7 - 26.5	19.2	51.3	19	0
Cobalt (Co)	Upper	7/8	1.9 - 4.8	2.7	5.8	470	0
	Lower	6/7	1.7 - 3.6	2.7	3.48	990	0
Copper (Cu)	Upper	8/8	4.1 - 34.0	12.7	240	310	0
	Lower	7/8	2.2 - 122	20.4	11.5	5,600	0
Iron (Fe)	Upper	8/8	4,260 - 13,600	7,360	NL	NL	NA
	Lower	7/7	4,330 - 13,100	8,160	NL	NL	NA

Table 10.1.3
AOC 671
Inorganic Analytical Results for Soil (mg/kg)

Parameters	Sample Interval	Detection Frequency	Detection Range	Mean	Background Concentration	RBC (upper) SSL (lower)	Number of Samples Exceeding: RBC and Background (upper) or SSL and Background (lower)
Lead (Pb)	Upper	8/8	6.1 - 39.8	19.9	203	400	0
	Lower	7/7	2.8 - 11.7	5.9	12.3	400	0
Magnesium (Mg)	Upper	8/8	589 - 2,240	1,280	NL	NL	NA
	Lower	7/7	733 - 2,450	1,460	NL	NL	NA
Manganese (Mn)	Upper	8/8	44.9 - 213	83.2	419	160	0
	Lower	7/7	30.9 - 128	77.8	118	480	0
Mercury (Hg)	Upper	1/8	0.26	0.26	0.47	2.3	0
	Lower	0/7	ND	ND	ND	1.0	0
Nickel (Ni)	Upper	8/8	3.3 - 8.8	5.9	23.9	160	0
	Lower	7/7	2.2 - 7.2	4.9	15.7	65	0
Potassium (K)	Upper	3/8	1,130 - 1,400	1,240	NL	NL	0
	Lower	5/7	670 - 2,210	1,520	NL	NL	0
Selenium (Se)	Upper	2/8	0.32 - 0.56	0.44	1.49	39	0
	Lower	4/7	0.33 - 1.5	0.94	1.77	2.6	0
Sodium (Na)	Upper	7/8	217 - 647	349	NL	NL	NA
	Lower	6/7	158 - 1,740	555	NL	NL	NA
Thallium (Tl)	Upper	2/8	0.33 - 0.39	0.36	ND	0.55	0
	Lower	1/7	0.34	0.34	ND	0.36	0
Tin (Sn)	Upper	2/8	1.4 - 9.5	5.5	7.5	4,700	0
	Lower	0/7	ND	ND	ND	5,500	0
Vanadium (V)	Upper	8/8	8.1 - 29.5	18.4	113	55	0
	Lower	7/7	10.3 - 26.7	18.0	38.1	3,000	0

Table 10.1.3
AOC 671
Inorganic Analytical Results for Soil (mg/kg)

Parameters	Sample Interval	Detection Frequency	Detection Range	Mean	Background Concentration	RBC (upper) SSL (lower)	Number of Samples Exceeding: RBC and Background (upper) or SSL and Background (lower)
Zinc (Zn)	Upper	8/8	19.7 - 73.7	38.1	206	2,300	0
	Lower	7/7	11.5 - 32.8	20.1	36.2	6,200	0

Notes:
NA = Not Applicable/Not Available
ND = Not Detected/Not Determined
NL = Not Listed
mg/kg = milligrams per kilogram
See Table 5.6 for inorganic element screening concentrations and their sources.

Table 10.1.4
AOC 671
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Volatile Organic Compounds (µg/kg)							
Acetone	671SB001	28	780000	NA	ND	8000	NA
	671SB006	31			36		
	671SB007	21			ND		
	671SB008	ND			33		
Acetonitrile (methyl cyanide)	671SB008	130	47000	NA	ND	440	NA
Toluene	671SB001	13	1600000	NA	12	6000	NA
	671SB005	2.5			ND		
	671SB006	2			2		
	671SB007	2			2		
	671SB008	4			7		
Semivolatile Organic Compounds (µg/kg)							
Acenaphthene	671SB002	975	470000	NA	ND	290000	NA
Anthracene	671SB002	3020	2300000	NA	ND	5900000	NA
Benzo(g,h,i)perylene	671SB002	235	310000	NA	ND	1.2E+08	NA
Benzo(a)pyrene Equivalents (BEQs)	671SB002	1088	87	NA	ND	1600	ND
Benzo(a)anthracene	671SB002	**1600**	870	NA	ND	800	NA
Benzo(a)pyrene	671SB002	**690**	87	NA	ND	4000	NA
Benzo(b)fluoranthene	671SB002	**1270**	870	NA	ND	2500	NA
Benzo(k)fluoranthene	671SB002	1420	8700	NA	ND	25000	NA

Table 10.1.4
AOC 671
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Chrysene	671SB002	1305	87000	NA	ND	80000	NA
Dibenz(a,h)anthracene	671SB002	70	87	NA	ND	800	NA
Indeno(1,2,3-cd)pyrene	671SB002	260	870	NA	ND	7000	NA
Dibenzofuran	671SB002	1225	31000	NA	ND	6800	NA
Di-n-butylphthalate	671SB002	ND	780000	NA	96	2300000	NA
	671SB003	100			NT		NA
	671SB004	98			130		
	671SB005	230			ND		
	671SB007	ND			51		
bis(2-Ethylhexyl)phthalate (BEHP)	671SB002	ND	46000	NA	76	1800000	NA
Fluoranthene	671SB002	6400	310000	NA	110	2100000	NA
	671SB004	65			ND		
	671SB007	38			ND		
Fluorene	671SB002	2160	310000	NA	ND	280000	NA
1-Methylnaphthalene	671SB002	110	310000	NA	ND	72000	NA
2-Methylnaphthalene	671SB002	58	310000	NA	ND	230000	NA
Naphthalene	671SB002	59	310000	NA	ND	42000	NA
N-Nitrosodimethylamine	671SB008	ND	13	NA	52	0.0026	NA
N-Nitroso-di-n-propylamine	671SB002	340	91	NA	ND	0.023	NA

Table 10.1.4
AOC 671
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Phenanthrene	671SB002	8900	230000	NA	ND	660000	NA
Pyrene	671SB002	4300	230000	NA	71	2100000	NA
	671SB004	57			ND		
Pesticides/PCBs (mg/kg)							
alpha-BHC (alpha-HCH)	671SB009	0.17	100	NA	NT	0.25	NA
beta-BHC (beta-HCH)	671SB002	20	350	NA	ND	1.3	NA
delta-BHC (delta-HCH)	671SB009	0.59	350	NA	ND	1.8	NA
4,4'-DDD	671SB002	5.8	2700	NA	60	8000	NA
	671SB003	4.8			NT		
	671SB005	21			ND		
	671SB006	31			ND		
	671SB007	430			19		
	671SB008	26			ND		
4,4'-DDE	671SB002	6	1900	NA	160	27000	NA
	671SB004	490			ND		
	671SB005	140			ND		
	671SB006	330			ND		
	671SB007	310			11		
	671SB008	120		NA	ND		NA

Table 10.1.4
AOC 671
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
4,4'-DDT	671SB005	16	1900	NA	ND	16000	NA
	671SB006	21			ND		
	671SB007	9.5			ND		
Dieldrin	671SB003	4.6	40	NA	NT	2	NA
	671SB010	0.19			NT		
Endosulfan I	671SB002	2.6	47000	NA	ND	9000	NA
	671SB007	1.9			ND		
Endosulfan sulfate	671SB009	0.33	47000	NA	NT	4600	NA
	671SB010	0.55			NT		
Endrin	671SB005	2.7	2300	NA	ND	500	NA
	671SB009	0.14			NT		
Endrin aldehyde	671SB002	1.7	2300	NA	ND	340	NA
	671SB003	2.1			NT		
	671SB004	ND			16		
	671SB005	1.6			ND		
	671SB006	ND			1.8		
	671SB009	0.78			NT		
Heptachlor epoxide	671SB004	8.7	70	NA	ND	330	NA
	671SB005	7.9			ND		

Table 10.1.4
AOC 671
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Organotin (mg/kg)							
Tetrabutyltin	671SB006	25.08	2300	NA	92.01	NA	NA
	671SB007	117.2			ND		
	671SB008	5.88			3.2		
Dioxin Compounds (ng/kg)							
2,3,7,8-TCDD equivalents (TEQs)	671SB002	0.213	4.3	NA	NT	1600	NA
	671SB005	2.10			NT		
123789-HxCDD	671SB005	2.412	43	NA	NT	4100	NA
1234678-HpCDD	671SB002	11.254	430	NA	NT	108000	NA
	671SB005	21.979			NT		
OCDD	671SB002	83.037	4300	NA	NT	1080000	NA
	671SB005	258.86			NT		
123478-HxCDF	671SB005	3.498	43	NA	NT	216000	NA
123678-HxCDF	671SB005	2.759	43	NA	NT	216000	NA
123789-HxCDF	671SB005	4.737	43	NA	NT	216000	NA
234678-HxCDF	671SB005	1.869	43	NA	NT	216000	NA
1234678-HpCDF	671SB002	1.481	430	NA	NT	54000	NA
	671SB005	8.344			NT		
OCDF	671SB002	2.856	4300	NA	NT	540000	NA
	671SB005	11.942			NT		

Table 10.1.4
AOC 671
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Inorganics (mg/kg)							
Aluminum (Al)	671SB001	8450	7800	27400	12500	560000	18900
	671SB002	7250			13600		
	671SB003	3870			NT		
	671SB004	5040			7450		
	671SB005	9030			6310		
	671SB006	7500			8690		
	671SB007	8430			4570		
	671SB008	12900			5390		
Antimony (Sb)	671SB006	ND	3.1	ND	6.2	2.7	ND
Arsenic (As)	671SB001	ND	0.43	21.6	5.1	15	6.45
	671SB002	3.95			6.3		
	671SB003	1.5			NT		
	671SB004	6.6			2.3		
	671SB005	8.3			3.6		
	671SB006	8.3			ND		
	671SB007	4.3			ND		
	671SB008	5.5			ND		

Table 10.1.4
AOC 671
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Barium (Ba)	671SB001	13	550	54.2	17	820	36
	671SB002	16.3			19.9		
	671SB003	10.2			NT		
	671SB004	15.2			37.1		
	671SB005	15.35			8.7		
	671SB006	15.5			12.6		
	671SB007	20.8			7.1		
	671SB008	19			7.6		
Beryllium (Be)	671SB002	0.365	16	0.95	0.61	32	0.67
	671SB004	0.34			0.86		
	671SB005	0.415			0.39		
	671SB008	0.72			ND		
Cadmium (Cd)	671SB007	0.5	7.8	0.61	ND	4	0.54
Chromium (Cr) (total)	671SB001	22.7	39	34.5	25.9	19	51.3
	671SB002	15			26.5		
	671SB003	10.6			NT		
	671SB004	16.9			24.6		
	671SB005	20.55			19.1		
	671SB006	12.4			16.8		
	671SB007	19.1			9.7		
	671SB008	22.5			11.9		

Table 10.1.4
AOC 671
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Chromium (Cr6) (hexavalent)	671SB002	0.01	39	ND	ND	19	ND
	671SB005	0.01			ND		
Cobalt (Co)	671SB001	2.1	470	5.8	3.5	990	3.48
	671SB002	2.3			3.6		
	671SB004	2			ND		
	671SB005	2.45			1.9		
	671SB006	1.9			3.1		
	671SB007	3.1			1.7		
	671SB008	4.8			2.5		
Copper (Cu)	671SB001	8	310	240	3.4	5600	11.5
	671SB002	4.7			5.2		
	671SB003	4.1			NT		
	671SB004	8.9			4		
	671SB005	33.95			122		
	671SB006	7.2			3.1		
	671SB007	25.6			2.2		
	671SB008	8.9			2.6		
Lead (Pb)	671SB001	6.1	400	203	7	400	12.3
	671SB002	15.3			11.7		
	671SB003	17.6			NT		
	671SB004	23.6			4.6		

Table 10.1.4
AOC 671
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Lead (Pb) (Continued)	671SB005	28.3			8.2		
	671SB006	19.4			3.1		
	671SB007	39.8			4.2		
	671SB008	9.3			2.8		
Manganese (Mn)	671SB001	44.9	160	419	124	480	118
	671SB002	87.45			128		
	671SB003	78.2			NT		
	671SB004	64.9			103		
	671SB005	65.85			49.3		
	671SB006	56.6			61.1		
	671SB007	54.9			30.9		
	671SB008	213			48.5		
Mercury (Hg)	671SB004	0.26	2.3	0.47	ND	1	ND
Nickel (Ni)	671SB001	8.8	160	23.9	6.6	65	15.7
	671SB002	4.55			7.2		
	671SB003	3.3			NT		
	671SB004	5.8			3.7		
	671SB005	6.55			6.4		
	671SB006	4.6			4.8		
	671SB007	7.2			2.2		
	671SB008	6.6			3.2		

Table 10.1.4
AOC 671
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Selenium (Se)	671SB001	0.56	39	1.49	1.0	2.6	1.77
	671SB002	ND			0.91		
	671SB004	ND			1.5		
	671SB006	0.32			0.33		
Thallium (Tl)	671SB006	0.39	0.55	ND	0.34	0.36	ND
	671SB007	0.33			ND		
Tin (Sn)	671SB003	1.4	4700	7.5	NT	5500	ND
	671SB008	9.5			ND		
Vanadium (V)	671SB001	18.3	55	113	25.2	3000	38.1
	671SB002	15.3			26.7		
	671SB003	8.1			NT		
	671SB004	17.8			21.7		
	671SB005	20.95			13.2		
	671SB006	17.3			17		
	671SB007	20.3			10.3		
	671SB008	29.5			12		
Zinc (Zn)	671SB001	19.7	2300	206	22.2	6200	36.2
	671SB002	27.5			32.8		
	671SB003	26.7			NT		
	671SB004	23.7			19.4		
	671SB005	45.1			24.9		

Table 10.1.4
AOC 671
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Zinc (Zn) (Continued)	671SB006	43.3			17.7		
	671SB007	73.7			11.5		
	671SB008	44.8			12.5		

Notes:

* = Residential RBCs (THQ=0.1) were used as a reference concentration for upper-interval samples. Generic soil-to groundwater SSLs (DAF=10) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996b) were used as a reference concentration for lower-interval samples

Bolded concentrations exceed both the RBC and the zone background
All background values for Zone I are based on twice the means of the grid sample concentrations.

GW = Groundwater
NA = Not applicable/not available
ND = Not detected
NT = Not taken
RBC = Risk-based concentration
SSL = Soil screening level
ng/kg = Nanograms per kilogram
mg/kg = Micrograms per kilogram

These detections were far below their respective RBCs. VOCs were not detected in subsurface soil sample GDISB01702. Appendix D contains the complete analytical data report for all grid-based soil samples collected at Zone I.

Semivolatile Organic Compounds in Soil

Twenty SVOCs were detected in surface soil at AOC 671. All surface soil Exceedances occurred in surface soil sample 671SB00201, where benzo(a)anthracene was detected at 1,600 μg/kg (RBC=870 μg/kg), benzo(a)pyrene was detected at 690 μg/kg (RBC=87 μg/kg), benzo(b)fluoranthene was detected at 1,270 μg/kg (RBC=870 μg/kg), and n-Nitroso-di-n-propylamine was detected at 340 μg/kg (RBC=91 μg/kg). Five SVOCs were detected in subsurface soil at AOC 671. Sample 671SB00802 contained n-Nitrosodimethylamine above its SSL at 52 μg/kg (SSL=0.0026 μg/kg). All other surface and subsurface soil SVOC detections were far below their respective RBCs and SSLs.

Similar to the AOC 671 soil sampling results, four SVOCs, benzo(b)fluoranthene (83 μg/kg), benzo(k)fluoranthene (98 μg/kg), fluoranthene (79 μg/kg), and pyrene (74 μg/kg) were detected in surface soil at grid soil boring GDISB017. All concentrations analytes were far below their RBCs. No SVOCs were detected in subsurface soil at GDISB017. Appendix D contains the complete analytical data report for all grid-based soil samples collected at Zone I.

In accordance with recent cPAH guidance (USEPA *Interim Supplemental Guidance to RAGS: Region IV Bulletins, Human Health Risk Assessment,* Bulletin No. 2 [USEPA 1995c]) and Section 7 of this report, BEQs were calculated for cPAHs at AOC 671. The BEQ for soil sample 671SB00201 is 1,088 μg/kg, which exceeds the RBC for benzo(a)pyrene of 87 μg/kg.

Pesticides and PCBs in Soil

Twelve pesticides were detected in surface soil at AOC 671. Three pesticides were detected in subsurface soil at this AOC. No pesticide concentrations in surface or subsurface soils at AOC 671 exceeded their RBC or SSL. No PCBs were detected in surface or subsurface soils at AOC 671.

Five pesticides were detected in surface soil at grid soil boring GDISB017, at concentrations similar to those present in the AOC 671 soil sampling results: 4,4'-DDD (11 μg/kg), 4,4'-DDE (390 μg/kg), 4,4'-DDT (21 μg/kg), endrin (16 μg/kg), and heptachlor epoxide (12 μg/kg).

No pesticides were detected in subsurface soil at GDISB017. No PCBs were detected in surface or subsurface soils at GDISB017. Appendix H contains the complete analytical data report for all grid-based samples collected at Zone I.

Other Organic Compounds in Soil

The organotin tetrabutyltin was detected in soil at AOC 671 at concentrations below the USEPA-approved screening concentration for tributyltin oxide of 2,300 μg/kg. The maximum surface soil detection was 117.2 μg/kg in sample 671SB00701. The maximum subsurface soil detection was 92.01 μg/kg in sample 671SB00602.

Dioxins and furans were detected in both duplicate samples collected at AOC 671. In accordance with recent dioxin guidance (USEPA *Interim Supplemental Guidance to RAGS: Region IV Bulletins Human Health Risk Assessment*, Bulletin No. 2 [USEPA 1995c]), and Section 7 of this report, the following TEQs were calculated: 2.13E-04 μg/kg and 2.10E-03 μg/kg for samples 671CB00501 and 671CB00201, respectively. Calculated TEQs at AOC 671 are below the RBC of 4.3E-03 μg/kg for 2,3,7,8-TCDD in soil.

Inorganic Elements in Soil

Twenty-two metals were detected in surface soil at AOC 671. No surface soil metal exceeded its RBC and surface soil background concentration. Twenty metals were detected in subsurface soil at AOC 671. Sample 671SB00602 contained antimony (6.2 mg/kg), which exceeded its SSL of 2.7 mg/kg. No subsurface background was established for antimony in Zone I. No other subsurface metals exceeded its SSL.

Nineteen metals were detected in surface soil at grid soil boring GDISB017, while 18 metals were detected in subsurface soil at this boring. No surface or subsurface metals exceeded its RBC, SSL, or surface/subsurface soil background concentration. Appendix D contains the complete analytical data report for all grid-based samples collected at Zone I.

10.1.3 Groundwater Sampling and Analysis

To characterize the site groundwater, four shallow monitoring wells were installed and sampled in accordance with the approved final RFI work plan. Four-rounds of groundwater sampling were completed at AOC 671. During the first round of sampling, AOC 671 wells were sampled for VOCs, SVOCs, metals, cyanide, pesticides, PCBs, chloride, sulfate, and TDS at DQO Level III. Samples from rounds two and three were analyzed for metals, cyanide, and pesticides and PCBs. Fourth-round samples were analyzed for metals, cyanide, pesticides and PCBs, chloride, sulfate, and TDS. Table 10.1.5 summarizes the groundwater sampling at AOC 671.

Table 10.1.5
AOC 671
Groundwater Sampling Summary

Sampling Round	Sampling Date	Wells Sampled	Sample Analyses	Comments
1	05/24/95	671001	Standard suite	No deviations from RFI work plan.
	05/25/95	671002	Chloride, TDS, sulfate	
	06/02/95	671003		
	06/02/95	671004		
2	01/16/96	671001	Cyanide, metals, pesticides and PCBs	Second round
	01/16/96	671002		
	01/16/96	671003		
	01/16/96	671004		
	01/16/96	Duplicate - 1	Appendix IX. Cyanide, metals, pesticides and PCBs	Duplicate sample collected from well 671004.
3	06/03/96	671001	Cyanide, metals, pesticides and PCBs	Third round
	06/03/96	671002		
	06/03/96	671003		
	06/04/96	671004		
	06/04/96	Duplicate - 1	Appendix IX. Cyanide, metals, pesticides and PCBs	Duplicate sample collected from 671004.
4	08/30/96	671001	Chloride, cyanide, sulfate, metals, pesticides and PCBs, TDS	Fourth round
	08/30/96	671002		
	08/30/96	671003		
	09/04/96	671004		
	09/04/96	Duplicate - 1	Appendix IX. Chloride, cyanide, sulfate, metals, pesticides and PCBs, TDS	Duplicate sample collected from 671004.

Notes:
Standard Suite = VOCs, SVOCs, metals, cyanide, pesticides and PCBs at DQO Level III.
Appendix IX = Standard suite, plus hex-chrome, dioxins, herbicides, pesticides at DQO Level IV.

Groundwater samples were also collected from a shallow/deep grid monitoring well pair (GDI017/GDI17D) near AOC 671. Both wells were sampled during all four sampling events, and all samples were analyzed for the standard suite of parameters, plus chloride, sulfate, and TDS. Results of these analyses are discussed in the AOC 671 nature and extent section and are presented in Appendix H.

Figure 10.1.1 shows the AOC 671 monitoring well locations. All shallow monitoring wells at AOC 671 were installed between 12.5 to 13.0 feet bgs in the upper sand layer of the Wando Formation. Deep grid well GDI17D was installed at 46 feet bgs. All wells were installed in accordance with Section 3.2.3 of this report.

10.1.4 Nature and Extent of Contamination in Groundwater

No organic compounds were detected in groundwater AOC 671. Table 10.1.6 summarizes the AOC 671 inorganic analytical results for groundwater from the four sampling rounds. Table 10.1.7 summarizes all analytes detected in the shallow groundwater for AOC 671. Appendix D contains the complete analytical report for all samples collected in Zone I.

Volatile Organic Compounds in Groundwater

No VOCs were detected in shallow groundwater at AOC 671.

No VOCs were detected in shallow groundwater at grid well GDI017. During the first sampling round, carbon disulfide was detected in deep groundwater at grid well GDI17D at a concentration far below its tap-water RBC. In subsequent sampling rounds, no VOCs were detected from this well. Appendix D contains the complete analytical data report for all grid-based samples collected at Zone I.

Semivolatile Organic Compounds in Groundwater

No SVOCs were detected in shallow groundwater at AOC 671.

Two SVOCs, acenaphthene and naphthalene, were detected in shallow groundwater (sampling rounds two through four) at GDI017. All concentrations were far below the appropriate tap-water RBCs. Once SVOC, benzoic acid, was detected in deep groundwater (sampling rounds two through four) at deep grid well GDI17D. This detection was far below the its tap-water RBC. Appendix D contains the complete analytical data report for all grid-based samples collected at Zone I.

Pesticides and PCBs in Groundwater

No pesticides or PCBs were detected in shallow groundwater at AOC 671.

Table 10.1.6
AOC 671
Inorganic Analytical Results for Groundwater (μg/L)

Parameters	Sample Round	Detection Frequency	Detection Range	Mean	Tap-water RBC/MCL	Shallow Background	Number of Samples Exceeding Lower of RBC or MCL and Background
Aluminum (Al)	First	0/4	ND	ND	3,700/NL	1,440	0
	Second	2/4	47.5 - 76.3	61.9			0
	Third	0/4	ND	ND			0
	Fourth	2/4	85 - 172	129			0
Arsenic (As)	First	2/4	17.2 - 31.4	24.3	0.045/50	23	1
	Second	2/4	9.5 - 42.0	25.8			1
	Third	3/4	9.9 - 28.8	16.3			1
	Fourth	2/4	10.4 - 38.9	24.7			1
Barium (Ba)	First	4/4	15.4 - 22.5	19.1	260/2,000	110	0
	Second	4/4	16.9 - 21.5	18.7			0
	Third	0/4	ND	ND			0
	Fourth	4/4	18.2 - 21.6	19.6			0
Beryllium (Be)	First	0/4	ND	ND	7.3/4	1.1	0
	Second	0/4	ND	ND			0
	Third	0/4	ND	ND			0
	Fourth	1/4	0.49	0.49			0
Cadmium (Cd)	First	2/4	0.30 - 0.30	0.30	1.8/5	NA	0
	Second	0/4	ND	ND			0
	Third	0/4	ND	ND			0
	Fourth	1/4	0.65	0.65			0
Calcium (Ca)	First	4/4	101,000 - 131,000	117,000	NL/NL	NL	NA
	Second	4/4	108,500 - 133,000	123,000			NA
	Third	4/4	102,500 - 140,000	122,000			NA
	Fourth	4/4	104,000 - 144,000	124,000			NA
Chromium (Cr)	First	2/4	0.90 - 0.93	0.92	18/100	14.3	0
	Second	0/4	ND	ND			0
	Third	2/4	1.1 - 1.2	1.15			0
	Fourth	1/4	0.93	0.93			0
Copper (Cu)	First	0/4	ND	ND	150/1,300	4.4	0
	Second	1/4	3.4	3.4			0
	Third	0/4	ND	ND			0
	Fourth	0/4	ND	ND			0
Iron (Fe)	First	4/4	1,580 - 3,640	2,570	NL/NL	NL	NA
	Second	4/4	1,940 - 4,730	3,330			NA
	Third	4/4	493 - 4,590	2,540			NA
	Fourth	4/4	533 - 4,060	2,685			NA
Lead (Pb)	First	3/4	2.0 - 6.8	3.8	15/15	4.4	0
	Second	0/4	ND	ND			0
	Third	0/4	ND	ND			0
	Fourth	2/4	3.4 - 7.7	5.6			0
Magnesium (Mg)	First	4/4	53,400 - 91,400	65,400	NL/NL	NL	NA
	Second	4/4	46,200 - 93,600	70,700			NA
	Third	4/4	50,500 - 94,200	73,700			NA
	Fourth	4/4	57,900 - 112,000	79,600			NA
Manganese (Mn)	First	4/4	659 - 908	754	73/NL	5,430	0
	Second	4/4	607 - 1,000	787			0
	Third	4/4	467 - 743	625			0
	Fourth	4/4	582 - 752	663			0

Table 10.1.6
AOC 671
Inorganic Analytical Results for Groundwater (μg/L)

Parameters	Sample Round	Detection Frequency	Detection Range	Mean	Tap-water RBC/MCL	Shallow Background	Number of Samples Exceeding Lower of RBC or MCL and Background
Mercury (Hg)	First	0/4	ND	ND	1.1/2	ND	0
	Second	0/4	ND	ND			0
	Third	0/4	ND	ND			0
	Fourth	1/4	37.9	37.9			1
Nickel (Ni)	First	0/4	ND	ND	73/100	13.3	0
	Second	0/4	ND	ND			0
	Third	1/4	1.5	1.5			0
	Fourth	1/4	1.0	1.0			0
Potassium (K)	First	4/4	46,200 - 81,400	56,300	NL/NL	NL	NA
	Second	4/4	30,400 - 58,500	44,700			NA
	Third	4/4	36,800 - 54,100	46,200			NA
	Fourth	3/4	40,000 - 63,600	49,000			NA
Sodium (Na)	First	4/4	178,000 - 489,000	269,000	NL/NL	NL	NA
	Second	4/4	90,600 - 695,000	371,000			NA
	Third	4/4	155,000 - 746,000	395,000			NA
	Fourth	4/4	191,000 - 671,000	391,000			NA
Thallium (Tl)	First	0/4	ND	ND	0.26/2	2	0
	Second	0/4	ND	ND			0
	Third	0/4	ND	ND			0
	Fourth	2/4	5.5 - 6.6	6.1			2
Vanadium (V)	First	2/4	1.2 - 1.3	1.3	26/NL	14	0
	Second	2/4	1.1 - 1.5	1.3			0
	Third	0/4	ND	ND			0
	Fourth	3/4	0.55 - 0.94	0.79			0
Zinc (Zn)	First	4/4	3.8 - 10.2	6.5	1,100/NL	24.4	0
	Second	1/4	6.9	6.9			0
	Third	0/4	ND	ND			0
	Fourth	1/4	5.3	5.3			0

Notes:
NA = Not Applicable/Not Available
ND = Not Detected/Not Determined
NL = Not Listed
μg/L = micrograms per liter
See Table 5.6 for inorganic screening concentrations and their sources.

Table 10.1.7
AOC 671
Analytes Inorganics Detected in Shallow Groundwater (μg/L)

Parameter	Location	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Tap-water RBC*	MCL/SMCL*	Shallow Background
Aluminum (Al)	671001	ND	76.3	ND	ND	3700	NL	1440
	671003	ND	ND	ND	172			
	671004	ND	47.45	ND	85			
Arsenic (As)	671001	ND	ND	10.1	ND	0.045	50	23
	671003	31.4	42	28.8	38.9			
	671004	17.2	9.5	9.9	10.4			
Barium (Ba)	671001	22.5	19.4	ND	18.7	260	2000	110
	671002	19.5	17.1	ND	20			
	671003	19	16.9	ND	18.2			
	671004	15.4	21.45	ND	21.55			
Beryllium (Be)	671004	ND	ND	ND	0.485	7.3	4	1.1
Cadmium (Cd)	671003	0.3	ND	ND	0.65	1.8	5	NA
	671004	0.3	ND	ND	ND			
Chromium (Cr) (total)	671002	ND	ND	1.1	ND	18	100	14.3
	671003	0.9	ND	1.2	ND			
	671004	0.93	ND	ND	0.93			
Copper (Cu)	671002	ND	3.4	ND	ND	150	1300	4.4
Lead (Pb)	671001	2	ND	ND	ND	15	15	4.4
	671002	6.8	ND	ND	3.4			
	671003	ND	ND	ND	7.7			
	671004	2.5	ND	ND	ND			

Table 10.1.7
AOC 671
Analytes Inorganics Detected in Shallow Groundwater (µg/L)

Parameter	Location	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Tap-water RBC*	MCL/SMCL*	Shallow Background
Manganese (Mn)	671001	908	1000	666	640	73	NL	5430
	671002	659	671	622	679			
	671003	780	871	743	752			
	671004	668	606.5	467	581.5			
Nickel (Ni)	671004	ND	ND	1.5	1	73	100	13.3
Thallium (Tl)	671001	ND	ND	ND	5.5	0.26	2	6.6
	671003	ND	ND	ND	6.6			
Vanadium (V)	671001	ND	1.5	ND	0.94	26	NL	14
	671002	ND	1.1	ND	0.55			
	671003	1.3	ND	ND	0.88			
	671004	1.2	ND	ND	ND			
Zinc (Zn)	671001	10.2	ND	ND	ND	1100	NL	24.4
	671002	6.1	ND	ND	ND			
	671003	6	6.9	ND	ND			
	671004	3.8	ND	ND	5.3			

Notes:

*	=	Tap-water RBCs (THQ=0.1) from *Risk-Based Concentration Table* (USEPA, October 22, 1997), and MCLs/SMCLs from *Drinking Water Regulations and Health Advisories* (USEPA, 1996e)

Bold concentrations exceed both the RBC and the zone background

All background values for Zone I are based on twice the means of the grid sample concentrations. Background values for the groundwater are based on two sampling rounds in two wells at each depth

ND	=	Not Detected
NL	=	Not Listed
RBC	=	Risk-Based Concentration
μg/L	=	micrograms per liter

No pesticides or PCBs were detected in shallow or deep groundwater at grid wells GDI017 and GDI17D. Appendix H contains the complete analytical data report for all grid-based samples collected at Zone I.

Other Organics in Groundwater

No dioxins, furans, herbicides, or organotins were detected in shallow groundwater at AOC 671.

Groundwater samples from grid wells GDI017 and GDI17D were not analyzed for dioxins, furans, herbicides, or organotins.

Inorganic Elements in Groundwater

Nineteen metals were detected in AOC 671 shallow groundwater samples. Arsenic exceeded its RBC (0.045 μg/L) and shallow groundwater background concentration (23 μg/L) during all four sampling rounds at 671003, with concentrations ranging from 28.8 to 42 μg/L. Mercury exceeded its tap-water RBC and MCL (1.1 μg/L and 2.0 μg/L) during the fourth sampling round at 671003, with a concentration of 37.9 μg/L. No background concentration has been established for mercury in shallow groundwater is established in Zone I. Thallium exceeded its tap-water RBC (0.26 μg/L), MCL (2 μg/L) and shallow background concentration (2 μg/L) during the fourth sampling round at 671001 (5.5 μg/L) and 671003 (6.6 μg/L).

In all, 14 metals were detected during the four groundwater sampling rounds at shallow grid well GDI017. All concentrations were far below their respective tap-water RBCs and shallow groundwater background concentrations. In all, 15 metals were detected during the four groundwater sampling rounds at deep grid well GDI17D. During the fourth sampling round, thallium exceeded its tap-water RBC (0.26 μg/L), MCL (2 μg/L) and deep groundwater background concentration (2.0 μg/L), with a concentration of 15.4 μg/L. Appendix H contains the complete analytical data report for all grid-based samples collected at Zone I.

10.1.5 Fate and Transport Assessment for AOC 671

AOC 671 includes the former Metering House at Building 3905G, and the two associated 25,000 gallon USTs. The tanks were constructed in 1944 and used to store aviation gasoline until 1966. The area is currently an unused asphalt parking lot. Two raised circular areas in the asphalt are thought to represent the locations of the USTs. The lack of information regarding the possible removal of these USTs and the surface expression suggests that the USTs are still in place. A concrete foundation along Hobson Avenue is all that remains of Building 3905G. No previous investigations or remedial actions have been documented for AOC 671. Environmental media samples collected as part of the AOC 671 investigation include surface soil, subsurface soil, and shallow (12.5 to 13.0 feet bgs) groundwater. In addition, one deep grid well was installed and sampled. Potential constituent migration pathways investigated for AOC 671 include soil-to-groundwater, groundwater migration to human receptors and to surface water, and emission of volatiles from surface soil-to-air.

10.1.5.1 Soil-to-Groundwater Cross-Media Transport

Table 10.1.8 compares maximum detected organic chemical concentrations in surface soil and subsurface soil, and shallow groundwater samples to risk-based soil screening levels considered protective of groundwater. Maximum concentrations in soil are compared to leachability-based generic SSLs. Soil background values for inorganics in Zone I were determined, but at the request of SCDHEC, they were not considered during initial comparisons of maximum soil concentrations to SSLs. To provide a conservative screen, generic SSLs are used; leachate entering the aquifer is assumed to be diluted by a ratio of 10:1, with no attenuation of constituents in soil (DAF=10).

Table 10.1.8
Organic Chemicals Detected in Surface Soil, Subsurface Soil, Sediment, and Shallow Groundwater
Comparison to Cross-media SSLs, Tap Water RBCs, and Saltwater Surface Water Chronic Screening Levels
AOC 671
Charleston Naval Complex
Charleston, South Carolina

Parameter	Maximum Concentration				Screening Concentration									
	Surface Soil	Subsurface Soil	Sediment	Shallow GW	Soil to GW SSL	Soil to Air SSL	Tap Water RBC	Saltwater Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Volatil-ization Potential	Ground-water Migration Concern	Surface Water Migration Concern
Volatile Organic Compounds														
Acetone	31	36	NA	ND	8000	1.0E+08	3700	NA	μG/KG	μG/L	NO	NO	NO	NO
Acetonitrile	130	ND	NA	ND	440 a	NA	220	NA	μG/KG	μG/L	NO	NO	NO	NO
Toluene	13	12	NA	ND	6000	650000	750	37	μG/KG	μG/L	NO	NO	NO	NO
Semivolatile Organic Compounds														
Acenaphthene	975	ND	NA	ND	290000	NA	2200	9.7	μG/KG	μG/L	NO	NO	NO	NO
Anthracene	3020	ND	NA	ND	5900000	NA	11000	NA	μG/KG	μG/L	NO	NO	NO	NO
Benzo(g,h,i)perylene	235	ND	NA	ND	1.2E+08 a	NA	1500	NA	μG/KG	μG/L	NO	NO	NO	NO
Benzo(a)pyrene Equivalents	1089	ND	NA	ND	1600 a	NA	0.0092	NA	μG/KG	μG/L	NO	NO	NO	NO
Benzo(a)anthracene c	1600	ND	NA	ND	800	NA	0.092	NA	μG/KG	μG/L	YES	NO	NO	NO
Benzo(a)pyrene c	690	ND	NA	ND	4000	NA	0.0092	NA	μG/KG	μG/L	NO	NO	NO	NO
Benzo(b)fluoranthene c	1270	ND	NA	ND	2500	NA	0.092	NA	μG/KG	μG/L	NO	NO	NO	NO
Benzo(k)fluoranthene c	1420	ND	NA	ND	25000	NA	0.92	NA	μG/KG	μG/L	NO	NO	NO	NO
Chrysene c	1305	ND	NA	ND	80000	NA	9.2	NA	μG/KG	μG/L	NO	NO	NO	NO
Dibenz(a,h)anthracene c	70	ND	NA	ND	800	NA	0.0092	NA	μG/KG	μG/L	NO	NO	NO	NO
Indeno(1,2,3-cd)pyrene c	260	ND	NA	ND	7000	NA	0.092	NA	μG/KG	μG/L	NO	NO	NO	NO
Dibenzofuran	1230	ND	NA	ND	6800 a	120000	24	NA	μG/KG	μG/L	NO	NO	NO	NO
Di-n-butylphthalate	230	130	NA	ND	2300000	2300000	3700	3.4	μG/KG	μG/L	NO	NO	NO	NO
bis(2-Ethylhexyl)phthalate (BEHP) c	ND	76	NA	ND	1800000	31000000	4.8	NA	μG/KG	μG/L	NO	NO	NO	NO
Fluoranthene	6400	110	NA	ND	2100000	NA	1500	1.6	μG/KG	μG/L	NO	NO	NO	NO
Fluorene	2160	ND	NA	ND	280000	NA	1500	NA	μG/KG	μG/L	NO	NO	NO	NO
1-Methylnaphthalene	110	ND	NA	ND	72000 a	NA	1500	NA	μG/KG	μG/L	NO	NO	NO	NO
2-Methylnaphthalene	58	ND	NA	ND	230000 a	NA	1500	23.5	μG/KG	μG/L	NO	NO	NO	NO
Naphthalene	59	ND	NA	ND	42000	NA	1500	23.5	μG/KG	μG/L	NO	NO	NO	NO
N-Nitrosodimethylamine c	ND	52	NA	ND	0.0026 a	NA	0.0013	NA	μG/KG	μG/L	YES	NO	NO	NO
N-Nitroso-di-n-propylamine c	340	ND	NA	ND	0.023	NA	0.0096	NA	μG/KG	μG/L	YES	NO	NO	NO
Phenanthrene	8900	ND	NA	ND	660000 a	NA	1100	NA	μG/KG	μG/L	NO	NO	NO	NO
Pyrene	4300	71	NA	ND	2100000	NA	1100	NA	μG/KG	μG/L	NO	NO	NO	NO
Pesticides/PCBs														
alpha-BHC (alpha-HCH) c	0.17	ND	NA	ND	0.25	800	0.011	1400	μG/KG	μG/L	NO	NO	NO	NO
beta-BHC (beta-HCH) c	20	ND	NA	ND	1.3	1E+09	0.037	NA	μG/KG	μG/L	YES	NO	NO	NO
delta-BHC (delta-HCH) c	0.59	ND	NA	ND	1.8 a	NA	0.037	NA	μG/KG	μG/L	NO	NO	NO	NO
4,4'-DDD c	430	60	NA	ND	8000	NA	0.28	0.025	μG/KG	μG/L	NO	NO	NO	NO
4,4'-DDE c	490	160	NA	ND	27000	NA	0.2	0.14	μG/KG	μG/L	NO	NO	NO	NO
4,4'-DDT c	21	ND	NA	ND	16000	1E+09	0.2	0.001	μG/KG	μG/L	NO	NO	NO	NO
Dieldrin c	4.6	ND	NA	ND	2	1000	0.0042	0.0019	μG/KG	μG/L	YES	NO	NO	NO

Table 10.1.8
Organic Chemicals Detected in Surface Soil, Subsurface Soil, Sediment, and Shallow Groundwater
Comparison to Cross-media SSLs, Tap Water RBCs, and Saltwater Surface Water Chronic Screening Levels
AOC 671
Charleston Naval Complex
Charleston, South Carolina

Parameter	Maximum Concentration Surface Soil	Subsurface Soil	Sediment	Shallow GW	Screening Concentration Soil to GW SSL	Soil to Air SSL	Tap Water RBC	Saltwater Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Volatil-ization Potential	Ground-water Migration Concern	Surface Water Migration Concern
Endosulfan I	2.6	ND	NA	ND	9000 b	NA	220	0.0087	µG/KG	µG/L	NO	NO	NO	NO
Endosulfan sulfate	0.55	ND	NA	ND	4600 a	NA	220	NA	µG/KG	µG/L	NO	NO	NO	NO
Endrin	2.7	ND	NA	ND	500	NA	11	0.0023	µG/KG	µG/L	NO	NO	NO	NO
Endrin aldehyde	2.1	16	NA	ND	340 a	NA	11	NA	µG/KG	µG/L	NO	NO	NO	NO
Heptachlor epoxide c	8.7	ND	NA	ND	330	5000	0.0012	0.0036	µG/KG	µG/L	NO	NO	NO	NO
Organotin														
Tetrabutyltin	117	92	NA	NA	NA	NA	11	NA	µG/KG	µG/L	NO	NO	NO	NO
Dioxin Compounds														
2,3,7,8-TCDD equivalents (TEQs) c	2.10	NA	NA	NA	1600 a	NA	0.45	10	NG/KG	PG/L	NO	NO	NO	NO
123789-HxCDD c	2.41	NA	NA	NA	4100 a	NA	4.5	NA	NG/KG	PG/L	NO	NO	NO	NO
1234678-HpCDD c	22.0	NA	NA	NA	108000 a	NA	45	NA	NG/KG	PG/L	NO	NO	NO	NO
OCDD c	259	NA	NA	NA	1080000 a	NA	450	NA	NG/KG	PG/L	NO	NO	NO	NO
123478-HxCDF c	3.50	NA	NA	NA	216000 a	NA	4.5	NA	NG/KG	PG/L	NO	NO	NO	NO
123678-HxCDF c	2.76	NA	NA	NA	216000 a	NA	4.5	NA	NG/KG	PG/L	NO	NO	NO	NO
123789-HxCDF c	4.74	NA	NA	NA	216000 a	NA	4.5	NA	NG/KG	PG/L	NO	NO	NO	NO
234678-HxCDF c	1.87	NA	NA	NA	216000 a	NA	4.5	NA	NG/KG	PG/L	NO	NO	NO	NO
1234678-HpCDF c	8.34	NA	NA	NA	54000 a	NA	45	NA	NG/KG	PG/L	NO	NO	NO	NO
OCDF c	11.9	NA	NA	NA	540000 a	NA	450	NA	NG/KG	PG/L	NO	NO	NO	NO

Notes:
Sources of screening concentrations appear in Table 5.5.
Explanations of fate and transport screening procedures appear in Section 6.2.
Frequency and range of detections, average detected concentrations, and number of screening concentration exceedances appear in Tables 10.1.2.

a - Calculated soil to groundwater SSL value (See Table 6.2)
b - Based on surrogate compound; see Table 5.5
c - Carcinogenic
GW - Groundwater

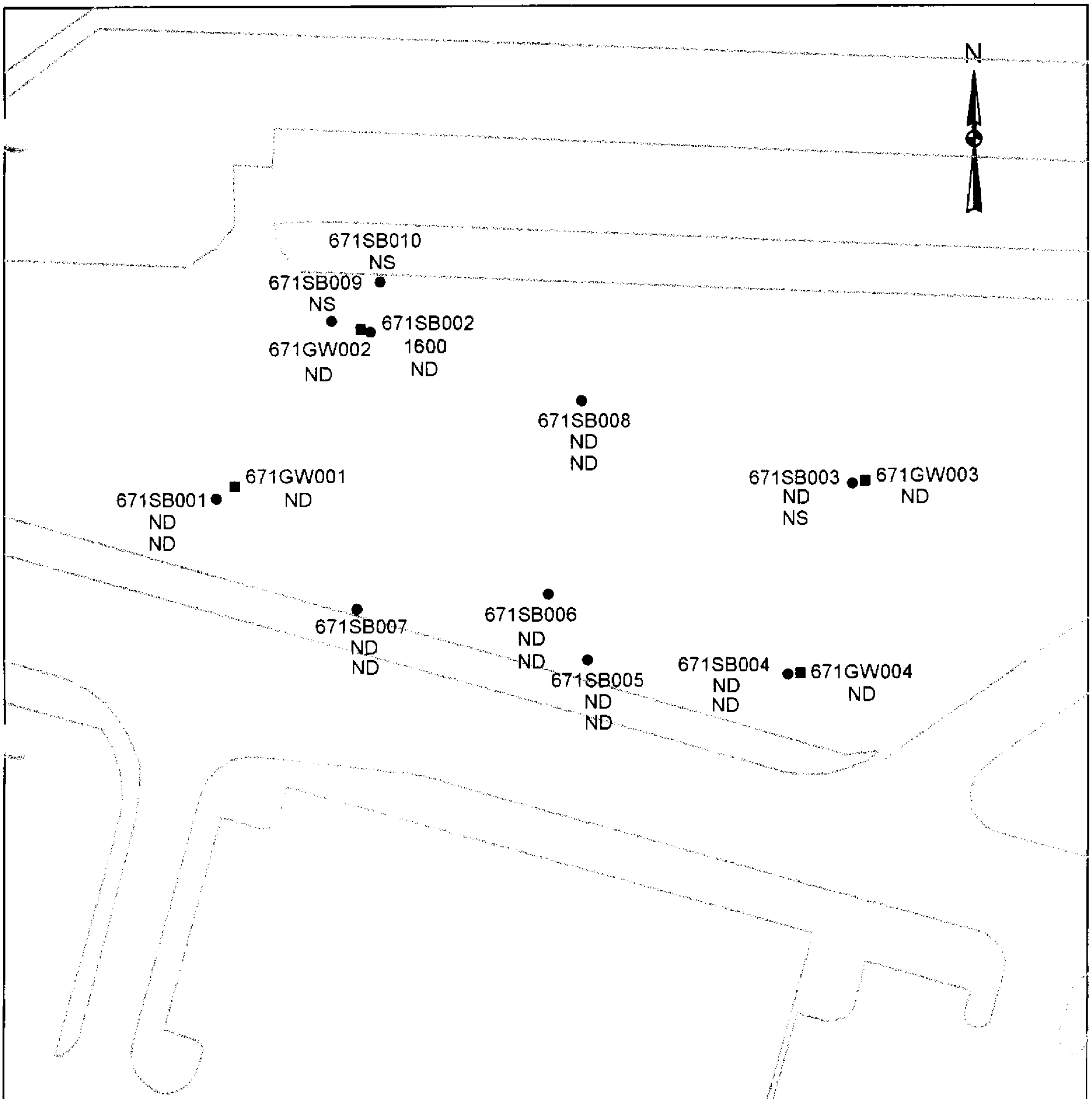
NA - Not applicable/not available
ND - Not detected
RBC - Risk-based concentration
SSL - Soil screening level

NG/KG - Nanograms per kilogram
µG/KG - Micrograms per kilogram
PG/L - Picograms per liter
µG/L - Micrograms per liter

No volatile organic constituents were detected in AOC 671 surface or subsurface soil at concentrations exceeding groundwater protection SSLs. Two semivolatile organic compounds were detected in AOC 671 surface soils at concentrations exceeding groundwater protection SSLs, but were nondetect in shallow groundwater: benzo(a)anthracene (1600 μg/kg at SB002; SSL=800 μg/kg) and N-Nitroso-di-n-propylamine (340 μg/kg at SB002; SSL=0.234 μg/kg). Figures 10.1.2 and 10.1.3 present benzo(a)anthracene and N-Nitroso-di-n-propylamine concentrations detected at AOC 671 respectively. One semivolatile organic compound was detected in subsurface soil at a single location exceeding the groundwater protection SSL, but was nondetect in all surface soil samples and shallow groundwater samples at AOC 671: N-Nitrosodimethylamine (52 μg/kg at SB008; SSL= 0.0026 μg/kg). Figure 10.1.4 presents the N-Nitrosodimethylamine concentration detected at AOC 671. These SVOCs may be associated with past site activities. However, the absence of benzo(a)anthracene and N-Nitroso-di-n-propylamine in subsurface soil effectively eliminates them from the soil-to-groundwater pathway. Further, the limited distribution of N-Nitrosodimethylamine in the subsurface soil and the fact that it was not present in site groundwater suggests that the affected area is small, and that residual mass is not significant. Two pesticides were detected in surface soil at concentrations exceeding groundwater protection SSLs: beta-BHC (20 μg/kg at SB002; SSL=1.3 μg/kg), and dieldrin (4.6 μg/kg at SB003; SSL=2.0 μg/kg). Figures 10.1.5 and 10.1.6 present beta-BHC and dieldrin concentrations detected at AOC 671 respectively. The subsurface soil samples at these locations were nondetect, thus indicating that the distribution of these organic constituents at this site is consistent with typical chemical behavior of pesticides in soils. This distribution is demonstrated by a marked attenuation with depth as constituents adsorb readily to organic carbon sites and soil media. Pesticide occurrence is not consistent with past site activities and their source at the site is unclear. They may be from routine application in the site area, or fugitive dust from a nearby area of application. The absence of these pesticides in subsurface soil and shallow groundwater, however, effectively invalidates a soil-to-groundwater pathway for pesticides. Table 10.1.9 compares maximum detected inorganic constituent concentrations in surface and subsurface soil samples to risk-based soil screening levels considered protective of groundwater. Three inorganics exceeded applicable SSLs in surface and subsurface soil at AOC 671. Specifically, chromium was detected in all eight surface and seven subsurface soil samples, exceeded applicable screening levels in four surface and four subsurface samples, and was detected in groundwater. Figure 10.1.7 presents chromium concentrations detected at AOC 671. Antimony was detected in one subsurface soil sample (6.2 μg/kg at location 671SB006) above the applicable SSL, but was not detected in surface soil or groundwater. Figure 10.1.8 presents antimony concentrations detected at AOC 671. Thallium was detected at a single location in surface soil only, slightly exceeding the groundwater protection SSL, was present slightly below the SSL in subsurface soil, and was detected in groundwater. Figure 10.1.9 presents thallium concentrations detected at AOC 671. The presence of inorganics at this site is not likely a result of the past site activities, which were related to the storage and transfer of petroleum. All of the chromium concentrations were well below the zone-specific background and are eliminated from further discussion regarding the site as the potential source. The absence of antimony in surface soil, but at concentrations above the SSL in subsurface soil implies either a subsurface source or downward migration via a mobilizing agent. Finally, the approximately equal vertical distribution of antimony points to a natural occurrence for this inorganic. Notably, only thallium and chromium were detected in shallow groundwater, and only thallium exceeded applicable groundwater risk-based screening criteria and the Zone I background reference concentration. The soil-to-groundwater pathway is valid for thallium and should be considered based on its presence at concentrations exceeding SSLs in surface soil, slightly below the SSL in subsurface soil, and in shallow AOC 671 groundwater at concentrations exceeding applicable groundwater screening levels.

10.1.5.2 AOC 671 Groundwater Migration to Surface Water Cross-Media Transport

Tables 10.1.8 and 10.1.9 compare maximum detected organic and inorganic concentrations in shallow groundwater samples to risk-based concentrations for drinking water and to chronic ambient saltwater quality criteria values for the protection of aquatic life (saltwater surface water chronic screening values).



LEGEND

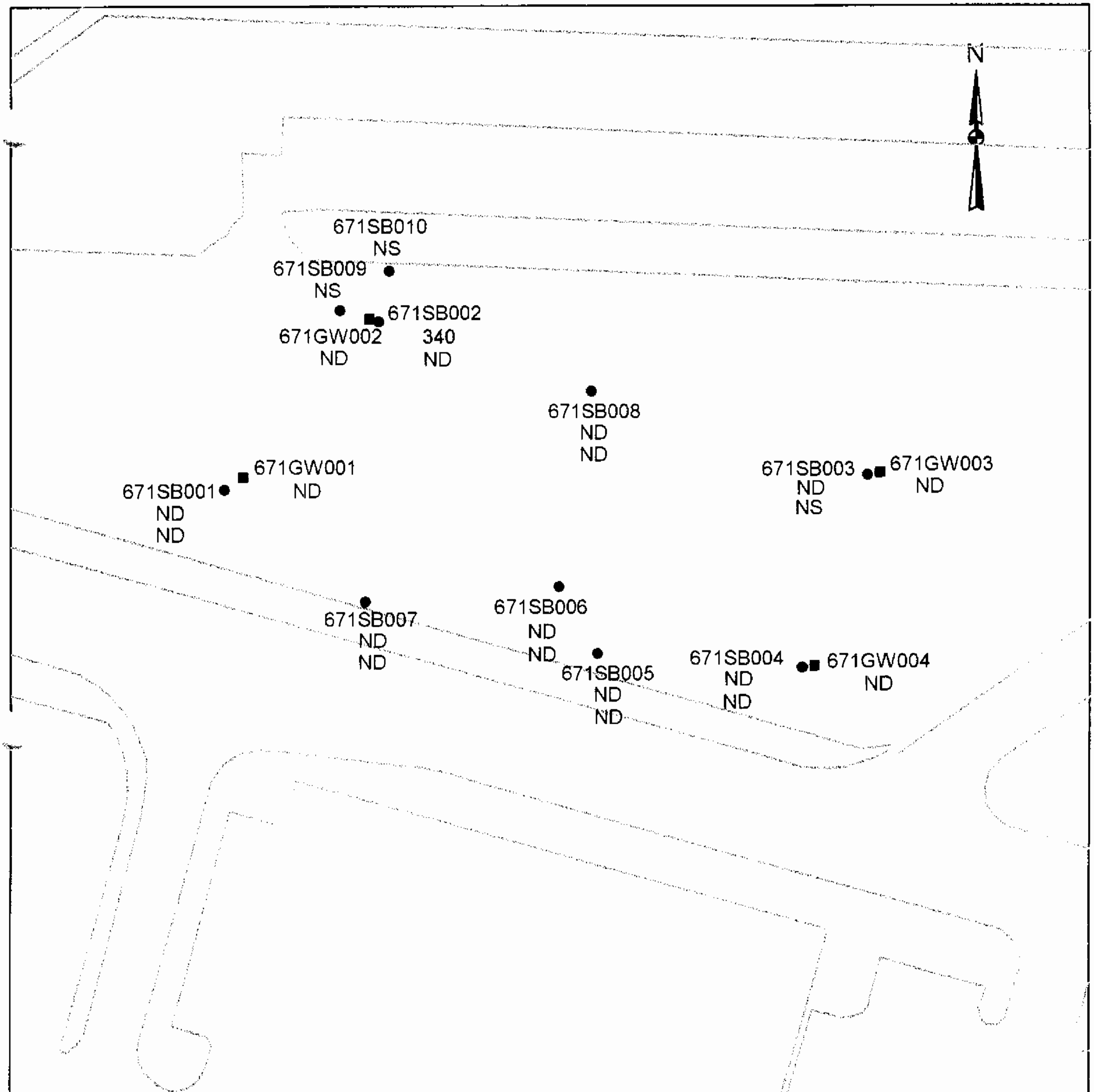
■ MONITORING WELL LOCATION
● ZONE I SOIL BORING LOCATION
12.30 ZONE I SURFACE SOIL CONC. (UG/KG)
12.30 ZONE I SUBSURFACE SOIL CONC. (UG/KG)
12.30 MAXIMUM QUARTERLY GW CONC. (UG/L)
NS NO SAMPLE TAKEN
ND NON DETECT

SCALE
40 0 40 80 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.1.2
ZONE I
AOC 671
BENZO(A)ANTHRACENE
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=NA RBC=870 UG/KG SSL=800 UG/KG



LEGEND

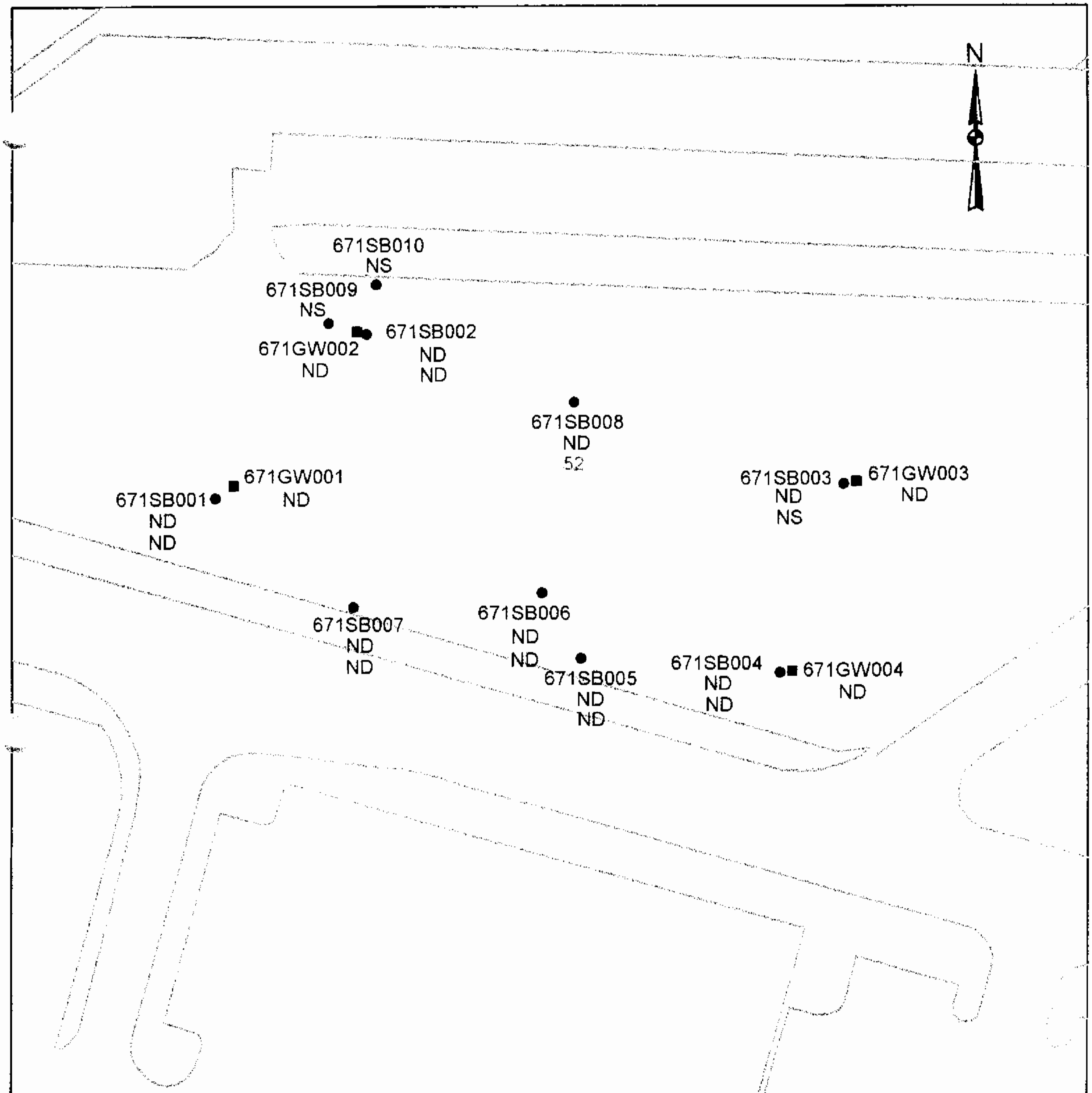
■ MONITORING WELL LOCATION
● ZONE I SOIL BORING LOCATION
12.30 ZONE I SURFACE SOIL CONC. (UG/KG)
12.30 ZONE I SUBSURFACE SOIL CONC. (UG/KG)
12.30 MAXIMUM QUARTERLY GW CONC. (UG/L)
NS NO SAMPLE TAKEN
ND NON DETECT

SCALE
40 0 40 80 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.1.3
ZONE I
AOC 671
N-NITROSO-DI-N-PROPYLAMINE
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=NA RBC=91 UG/KG SSL=.023 UG/KG



LEGEND

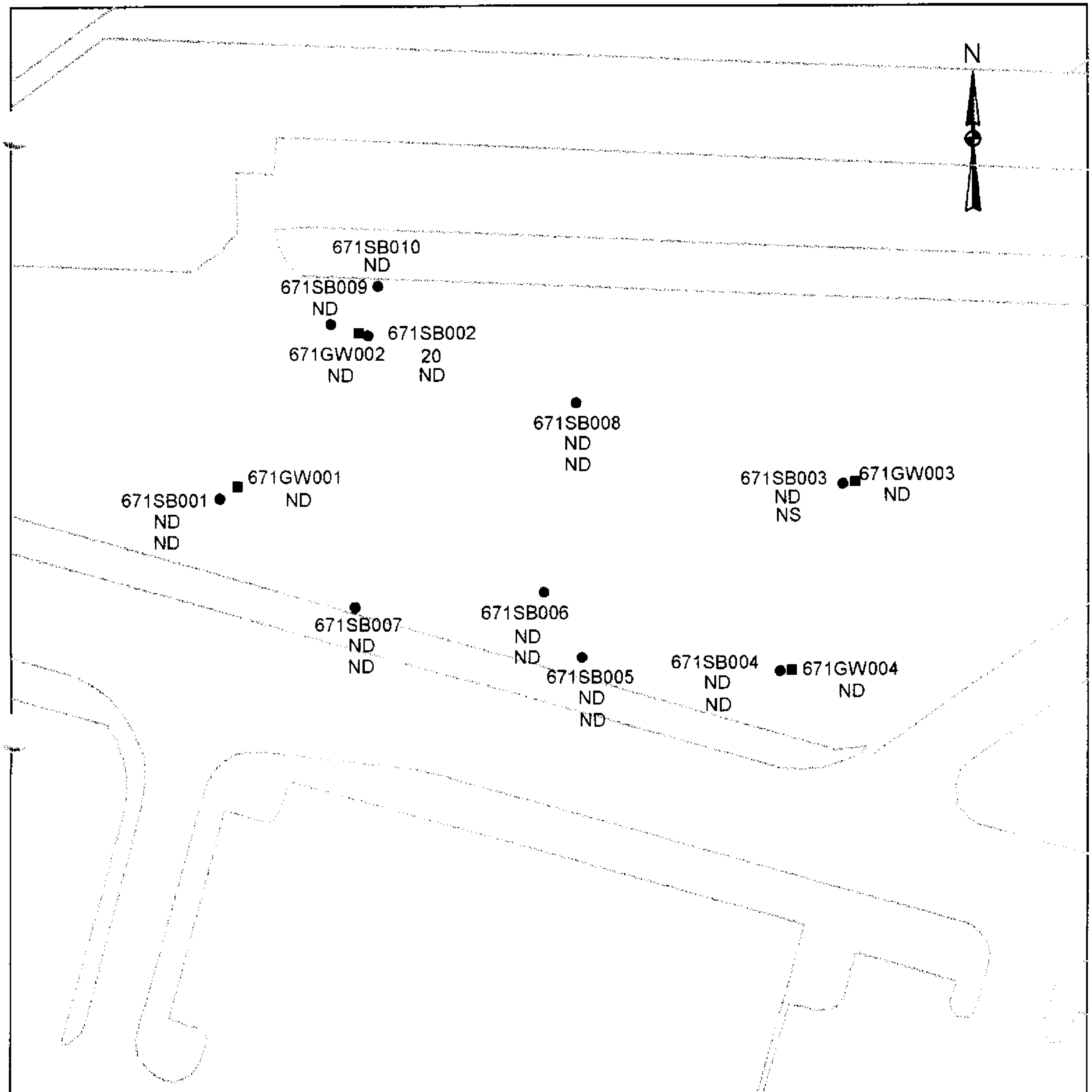
■ MONITORING WELL LOCATION
● ZONE I SOIL BORING LOCATION
12.30 ZONE I SURFACE SOIL CONC. (UG/KG)
12.30 ZONE I SUBSURFACE SOIL CONC. (UG/KG)
12.30 MAXIMUM QUARTERLY GW CONC. (UG/L)
NS NO SAMPLE TAKEN
ND NON DETECT

SCALE
40 0 40 80 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.1.4
ZONE I
AOC 671
N-NITROSODIMETHYLAMINE
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=NA RBC=13 UG/KG SSL=.0026 UG/KG



LEGEND

- ■ MONITORING WELL LOCATION
- ● ZONE I SOIL BORING LOCATION
- 12.30 ZONE I SURFACE SOIL CONC. (UG/KG)
- 12.30 ZONE I SUBSURFACE SOIL CONC. (UG/KG)
- *12.30* MAXIMUM QUARTERLY GW CONC. (UG/L)
- NS NO SAMPLE TAKEN
- ND NON DETECT

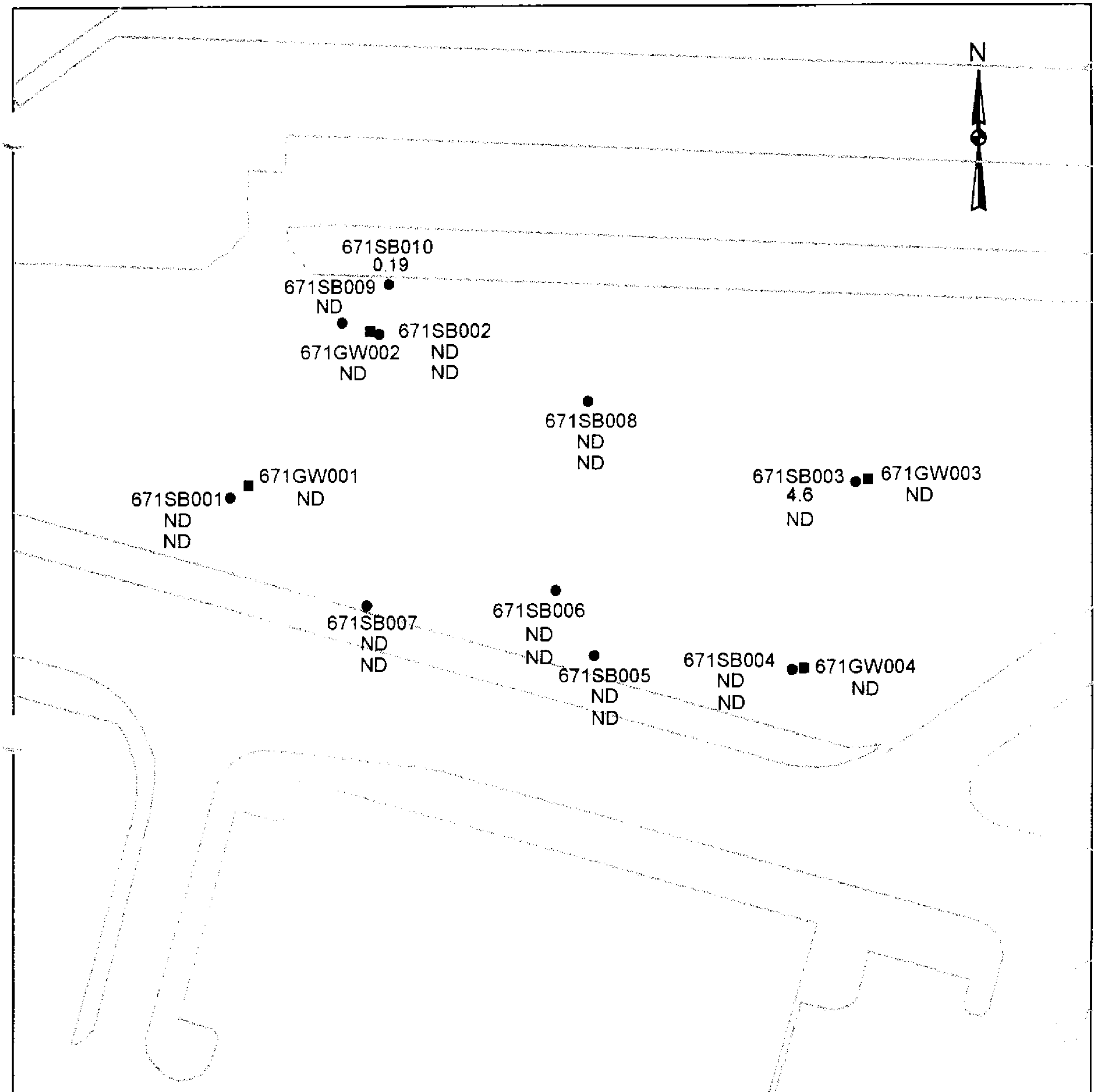
SCALE

40 0 40 80 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.1.5
ZONE I
AOC 671
BETA-BHC
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=NA RBC=350 UG/KG SSL=1.3 UG/KG



LEGEND

■ MONITORING WELL LOCATION
● ZONE I SOIL BORING LOCATION
12.30 ZONE I SURFACE SOIL CONC. (UG/KG)
12.30 ZONE I SUBSURFACE SOIL CONC. (UG/KG)
12.30 MAXIMUM QUARTERLY GW CONC. (UG/L)
NS NO SAMPLE TAKEN
ND NON DETECT

SCALE
40 0 40 80 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.1.6
ZONE I
AOC 671
DIELDRIN
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=NA RBC=40 UG/KG SSL=2 UG/KG

Table 10.1.9
Inorganic Chemicals Detected in Surface Soil, Subsurface Soil, Sediment, and Shallow Groundwater
Comparison to Cross-media SSLs, Tap Water RBCs, Saltwater Surface Water Chronic Screening Levels, and Background Reference Values
AOC 671
Charleston Naval Complex
Charleston, South Carolina

Parameter	Maximum Concentration: Surface Soil	Subsurface Soil	Sediment	Shallow GW	Screening Concentration: Soil to GW SSL	Soil Background	Soil to Air SSL	Tap Water RBC	Shallow GW Background	Saltwater Surf. Wtr Chronic	Soil Units	Water Units	Leaching Potential	Fugitive Particulate Inhalation Concern	Ground-water Migration Concern	Surface Water Migration Concern
Inorganic Chemicals																
Aluminum (Al)	12900	13600	NA	172	560000 a	27400	NA	37000	1440	NA	MG/KG	µG/L	NO	NO	NO	NO
Antimony (Sb)	ND	6.2	NA	ND	2.7	ND	NA	15	NA	NA	MG/KG	µG/L	YES	NO	NO	NO
Arsenic (As) c	8.3	6.3	NA	42	15	21.6	750	0.045	23	36	MG/KG	µG/L	NO	NO	YES	YES
Barium (Ba)	20.8	37.1	NA	22.5	820	54.2	690000	2600	110	NA	MG/KG	µG/L	NO	NO	NO	NO
Beryllium (Be)	0.72	0.86	NA	0.49	32	0.95	1300	73	1.1	NA	MG/KG	µG/L	NO	NO	NO	NO
Cadmium (Cd)	0.5	ND	NA	0.65	4	0.61	1800	18	NA	9.3	MG/KG	µG/L	NO	NO	NO	NO
Chromium (Cr) (total)	22.7	26.5	NA	1.2	19	51.3	270	180	14.3	50	MG/KG	µG/L	YES	NO	NO	NO
Cobalt (Co)	4.8	3.6	NA	ND	990 a	5.8	NA	2200	2.2	NA	MG/KG	µG/L	NO	NO	NO	NO
Copper (Cu)	34	122	NA	3.4	5600 a	240	NA	1500	4.4	2.9	MG/KG	µG/L	NO	NO	NO	YES
Lead (Pb)	39.8	11.7	NA	7.7	400	203	400	15	4.4	8.5	MG/KG	µG/L	NO	NO	NO	NO
Manganese (Mn)	213	128	NA	1000	480 a	419	NA	730	5430	NA	MG/KG	µG/L	NO	NO	NO	NO
Mercury (Hg)	0.26	ND	NA	37.9	1	0.47	10	11	NA	0.025	MG/KG	µG/L	NO	NO	YES	YES
Nickel (Ni)	8.8	7.2	NA	1.5	65	23.9	13000	730	13.3	8.3	MG/KG	µG/L	NO	NO	NO	NO
Selenium (Se)	0.56	1.5	NA	ND	2.6	1.77	NA	180	ND	71	MG/KG	µG/L	NO	NO	NO	NO
Thallium (Tl)	0.39	0.34	NA	6.6	0.36	ND	NA	2.6	2	21.3	MG/KG	µG/L	YES	NO	YES	NO
Tin (Sn)	9.5	ND	NA	ND	5500 a	7.5	NA	22000	NA	NA	MG/KG	µG/L	NO	NO	NO	NO
Vanadium (V)	29.5	26.7	NA	1.5	3000	113	NA	260	14	NA	MG/KG	µG/L	NO	NO	NO	NO
Zinc (Zn)	73.7	32.8	NA	10.2	6200	206	NA	11000	24.4	86	MG/KG	µG/L	NO	NO	NO	NO

Notes:
Sources of screening concentrations appear in Table 5.6
Explanations of fate and transport screening procedures appear in Section 6.2.
Frequency and range of detections, average detected concentrations, and number of screening concentration exceedances appear in Tables 10.1.3 and 10.1.6.

Background reference values for soil are shown for comparison purposes only.
Maximum groundwater concentrations are screened against the greater of tap water RBCs or corresponding background reference values to determine groundwater migration concern.

a - Calculated soil to groundwater SSL value (See Table 6.2)
c - Carcinogenic
GW - Groundwater
NA - Not available/Not applicable
ND - Not detected
RBC - Risk-based concentration
SSL - Soil screening level
MG/KG - Milligrams per kilogram
µG/L - Micrograms per liter

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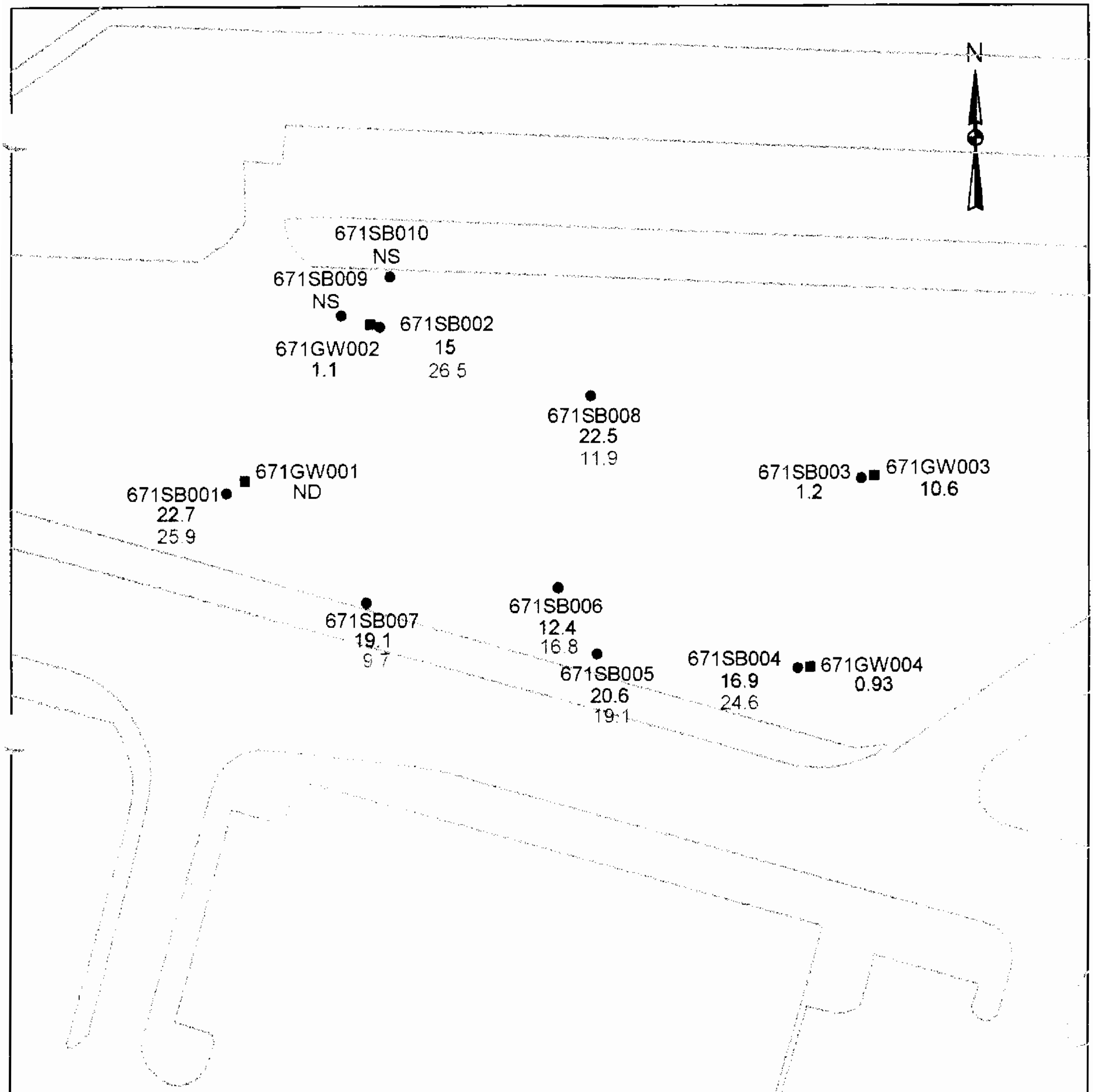


LEGEND

■ MONITORING WELL LOCATION
● ZONE I SOIL BORING LOCATION
12.30 ZONE I SURFACE SOIL CONC. (MG/KG)
12.30 ZONE I SUBSURFACE SOIL CONC. (MG/KG)
12.30 MAXIMUM QUARTERLY GW CONC. (UG/L)
NS NO SAMPLE TAKEN
ND NON DETECT

SCALE
40 0 40 80 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.1.7
ZONE I
AOC 671
CHROMIUM
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=100 UG/L RBC=39 MG/KG SSL=19 MG/KG

For inorganics, maximum concentrations in groundwater are screened against salt water, surface water, chronic values and whichever is greater: (a) risk-based drinking water concentrations or (b) corresponding background reference concentrations for groundwater. To provide a conservative screening, no attenuation or dilution of constituents in groundwater is assumed before comparison to the relevant standards.

No organic constituents were present in groundwater at concentrations exceeding the applicable RBC screening levels.

Three inorganic constituents, (arsenic, mercury, and thallium) were present in groundwater at levels that exceeded the RBCs. In addition, arsenic, copper, and mercury were present in 671002 and 671003 at concentrations that exceeded their surface water criteria. Arsenic was detected in all four-rounds of groundwater sampling in three of four monitoring wells at concentrations significantly above the applicable background and RBC for arsenic. Figure 10.1.10 presents arsenic concentrations detected at AOC 671. However, it should be noted that the point of departure for arsenic should be 23 μg/L, the zone-specific background value. Over four quarters of sampling, arsenic concentrations have remained essentially the same, with the site's highest concentrations consistently detected at 671003. During the most recent sampling, this well exhibited the only exceedance. Notably, arsenic in soil did not exceed its SSL, suggesting either an offsite source, aquifer naturally higher in arsenic, or an SSL too high for the site conditions. All samples exceed the applicable RBC for arsenic, but only one sample in the fourth-quarter exceeded the surface water criteria. Mercury was detected in one sample in the fourth round of groundwater sampling (671003) above the RBC. Figure 10.1.11 presents mercury concentrations detected at AOC 671. It was not detected in any of the first three rounds of sampling, suggesting either an error in the lab, a sample with high turbidity, or a pulse-type source. Thallium was detected in two samples in the fourth round (locations 671001 and 671003) at concentrations above the RBC and zone-specific background (Figure 10.1.9). The deep groundwater sample from this

AOC also exhibited thallium above the applicable RBC and background. Like mercury, thallium had been nondetect in the previous three quarters. The sudden occurrence of thallium and mercury exceedances suggests, at least, seasonal fluctuations in groundwater quality, or either sampling or analytical error. These hypotheses can be substantiated or refuted with additional sampling.

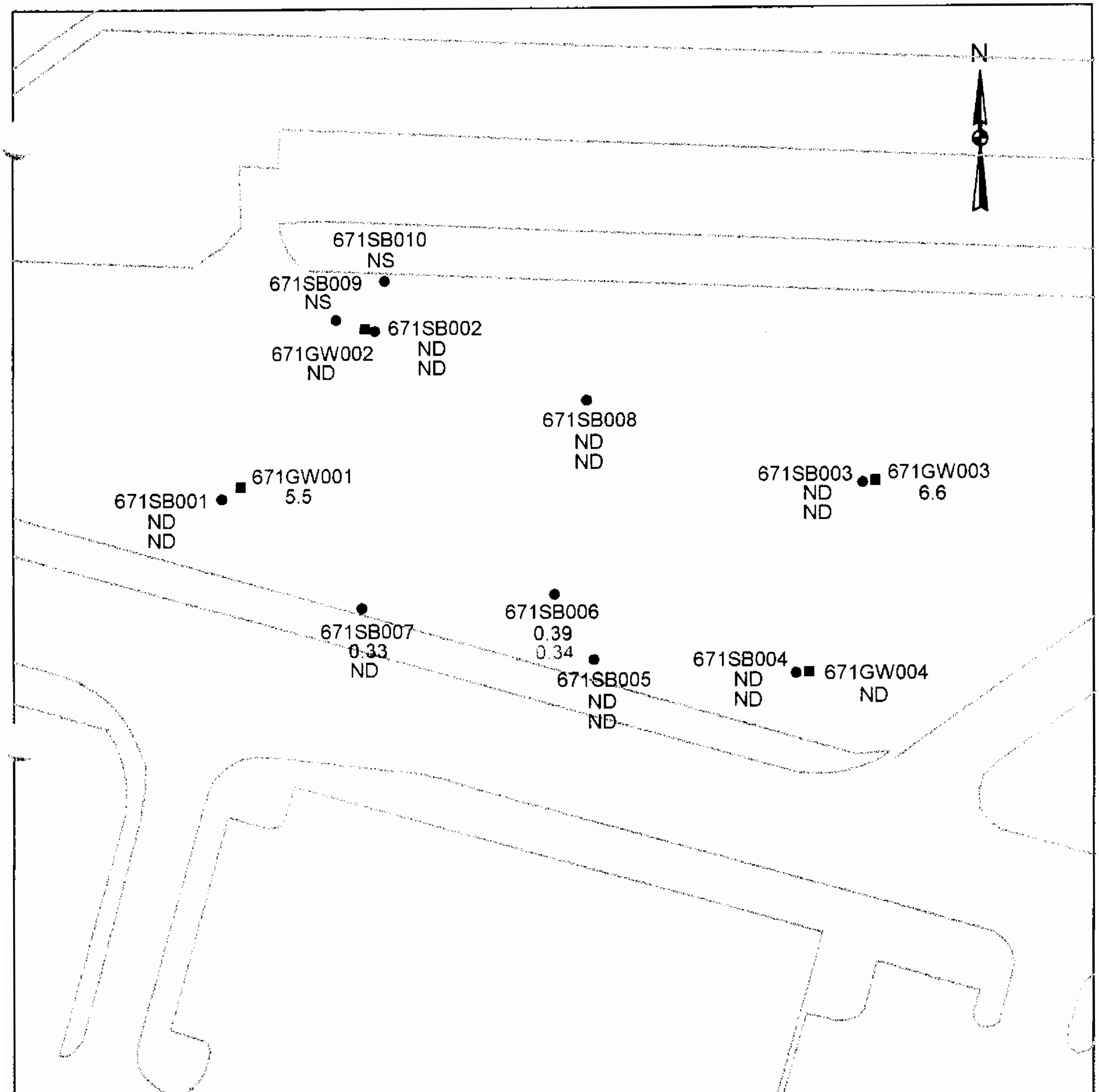
In addition to arsenic and mercury, copper exceeded the applicable surface water screening criteria. It exceeded this screening threshold in the second round at location 671002, but has since been below the screening criteria. Figure 10.1.12 presents copper concentrations detected at AOC 671.

Based on the fourth round of groundwater monitoring results, from a chemical standpoint, the groundwater-to-surface-water migration pathway does have merit. The nearest surface water receptor is the Cooper River, approximately 200 feet north of the site. At this site, groundwater flow is consistent with the discharge to the Cooper River; consequently, this pathway has some merit and should be considered valid. The significance of potential discharge to the river, however, will depend on the dilutional capacity of the system.

As for the RBC, or risk-based consumption pathway, groundwater in the surficial aquifer is not currently used for consumption, nor is it anticipated to be in the future, thus effectively invalidating the pathway.

10.1.5.3 AOC 671 Soil-to-Air Transport

No VOCs were detected at AOC 671. As a result, the soil-to-air migration pathway is not considered significant or valid at AOC 671.



LEGEND

- ■ MONITORING WELL LOCATION
- ● ZONE I SOIL BORING LOCATION
- 12.30 ZONE I SURFACE SOIL CONC (MG/KG)
- 12.30 ZONE I SUBSURFACE SOIL CONC. (MG/KG)
- *12.30* MAXIMUM QUARTERLY GW CONC. (UG/L)
- NS NO SAMPLE TAKEN
- ND NON DETECT

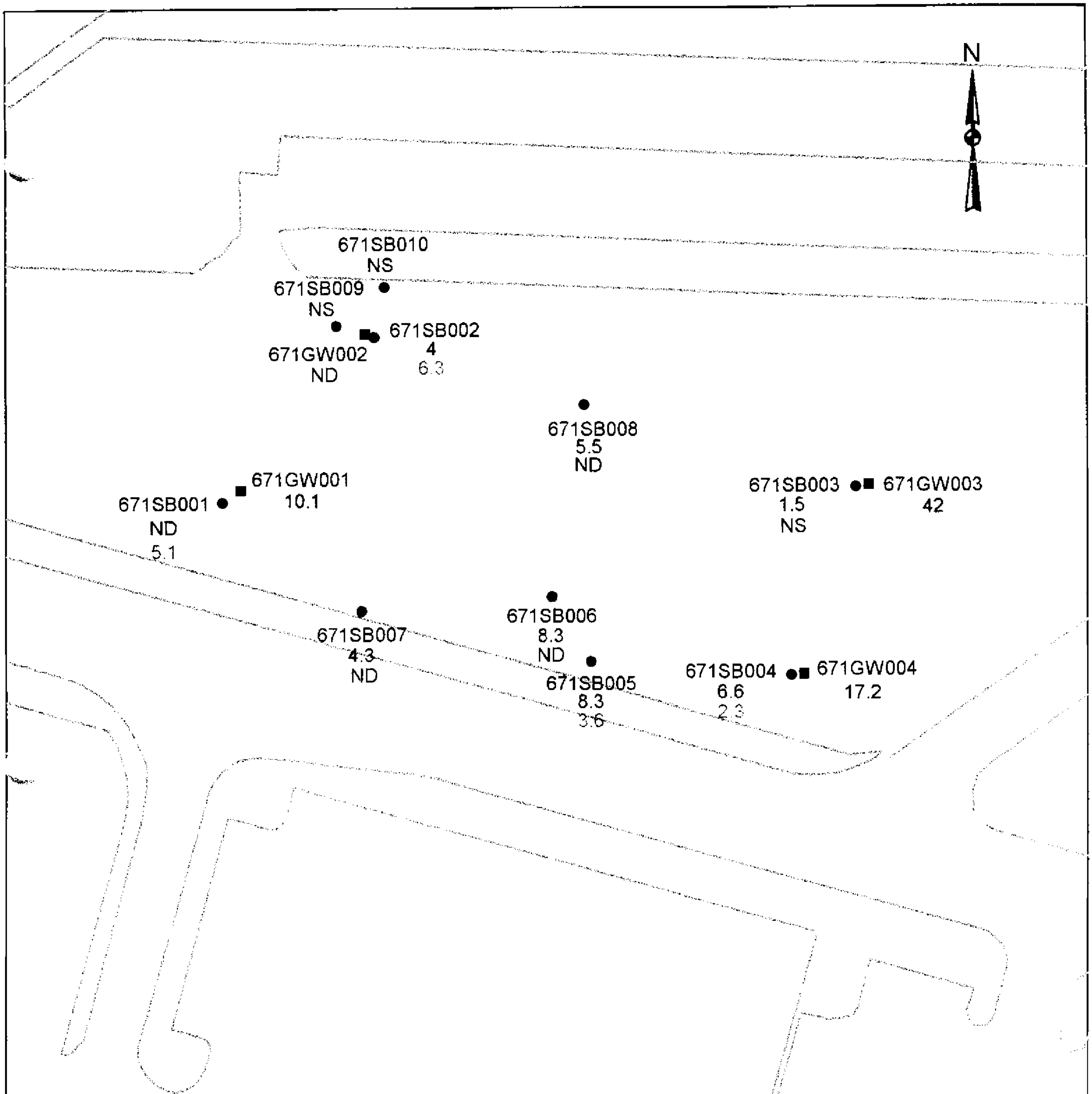
SCALE

40 0 40 80 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.1.9
ZONE I
AOC 671
THALLIUM
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=2 UG/L RBC=.55 MG/KG SSL=.36 MG/KG



LEGEND

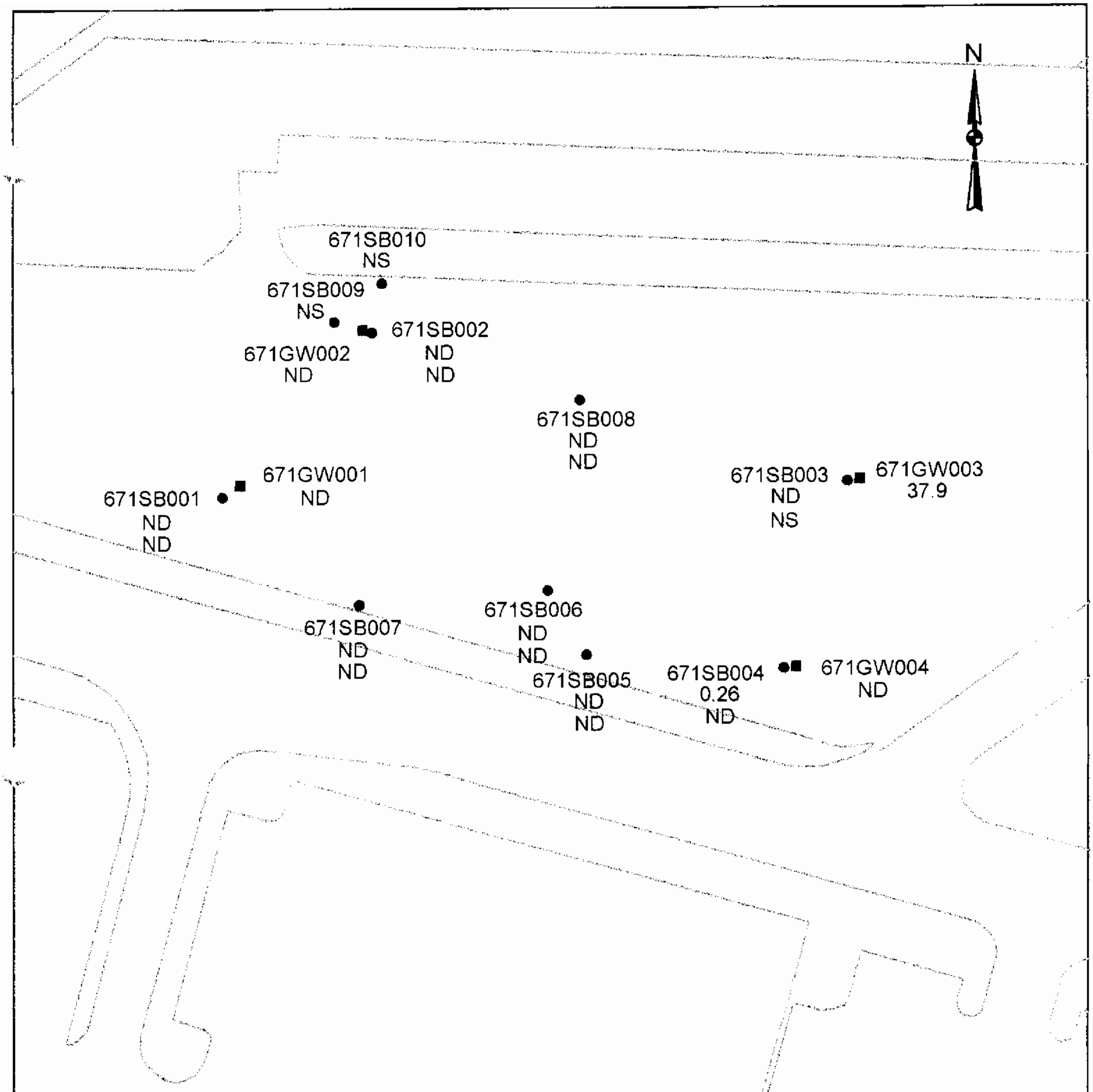
■ MONITORING WELL LOCATION
● ZONE I SOIL BORING LOCATION
12.30 ZONE I SURFACE SOIL CONC. (MG/KG)
12.30 ZONE I SUBSURFACE SOIL CONC. (MG/KG)
12.30 MAXIMUM QUARTERLY GW CONC. (UG/L)
NS NO SAMPLE TAKEN
ND NON DETECT

SCALE
40 0 40 80 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.1.10
ZONE I
AOC 671
ARSENIC
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=50 UG/L RBC=.43 MG/KG SSL=15 MG/KG



LEGEND

■ MONITORING WELL LOCATION
● ZONE I SOIL BORING LOCATION
12.30 ZONE I SURFACE SOIL CONC. (MG/KG)
12.30 ZONE I SUBSURFACE SOIL CONC. (MG/KG)
12.30 MAXIMUM QUARTERLY GW CONC. (UG/L)
NS NO SAMPLE TAKEN
ND NON DETECT

SCALE
40 0 40 80 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.1.11
ZONE I
AOC 671
MERCURY
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=2 UG/L RBC=2.3 MG/KG SSL=1 MG/KG

10.1.5.4 AOC 671 Fate and Transport Summary

No volatile organic constituents were detected in AOC 671 surface or subsurface soil at concentrations exceeding groundwater protection SSLs. All organic exceedances were limited to location 671SB002, except for one semivolatile and one pesticide at locations 671SB008 and 671SB003 respectively. Two semivolatile organic compounds, benzo(a)anthracene and N-Nitroso-di-n-propylamine, were detected in AOC 671 surface soils at concentrations exceeding groundwater protection SSLs. One semivolatile organic compound, N-Nitrosodimethylamine, was detected in subsurface soil at one location exceeding the groundwater protection SSL, but was nondetect in all surface soil samples. These organic constituents were all nondetect in shallow groundwater samples at AOC 671, thus invalidating the soil-to-groundwater pathway for these constituents. Two pesticides, beta-BHC, and dieldrin, were detected in surface soil at concentrations exceeding groundwater protection SSLs. The subsurface soil at these locations was nondetect, thus indicating that the pesticides are immobilized in the upper soil column, a distribution consistent with chemical behavior typical of pesticides in soils. The presence of these pesticides is not consistent with historical practices at the site; the pesticides may be the result of a previous application at the site or surrounding area. Three inorganics, chromium, antimony, and thallium, exceeded applicable SSLs in surface and subsurface soil at AOC 671. Chromium was detected in all surface and subsurface soil samples, and in the shallow groundwater. However, the concentration detected in the soil and groundwater did not exceed applicable background, thus eliminating it from further discussion. Antimony exceeded the SSL in subsurface soil, but was not present in shallow groundwater, thus invalidating the pathway for this inorganic. Thallium was detected in surface soil above the SSL, in subsurface soil slightly below the SSL, and above background and the RBC in the shallow and deep groundwater at the site. Although it is unlikely that the AOC is the source of this inorganic, the soil-to-groundwater-pathway is valid for thallium. Therefore, it should be considered, based on its presence at concentrations exceeding SSLs in surface soil, slightly below the SSL in subsurface soil, and in shallow AOC 671 groundwater at concentrations exceeding applicable groundwater screening levels.

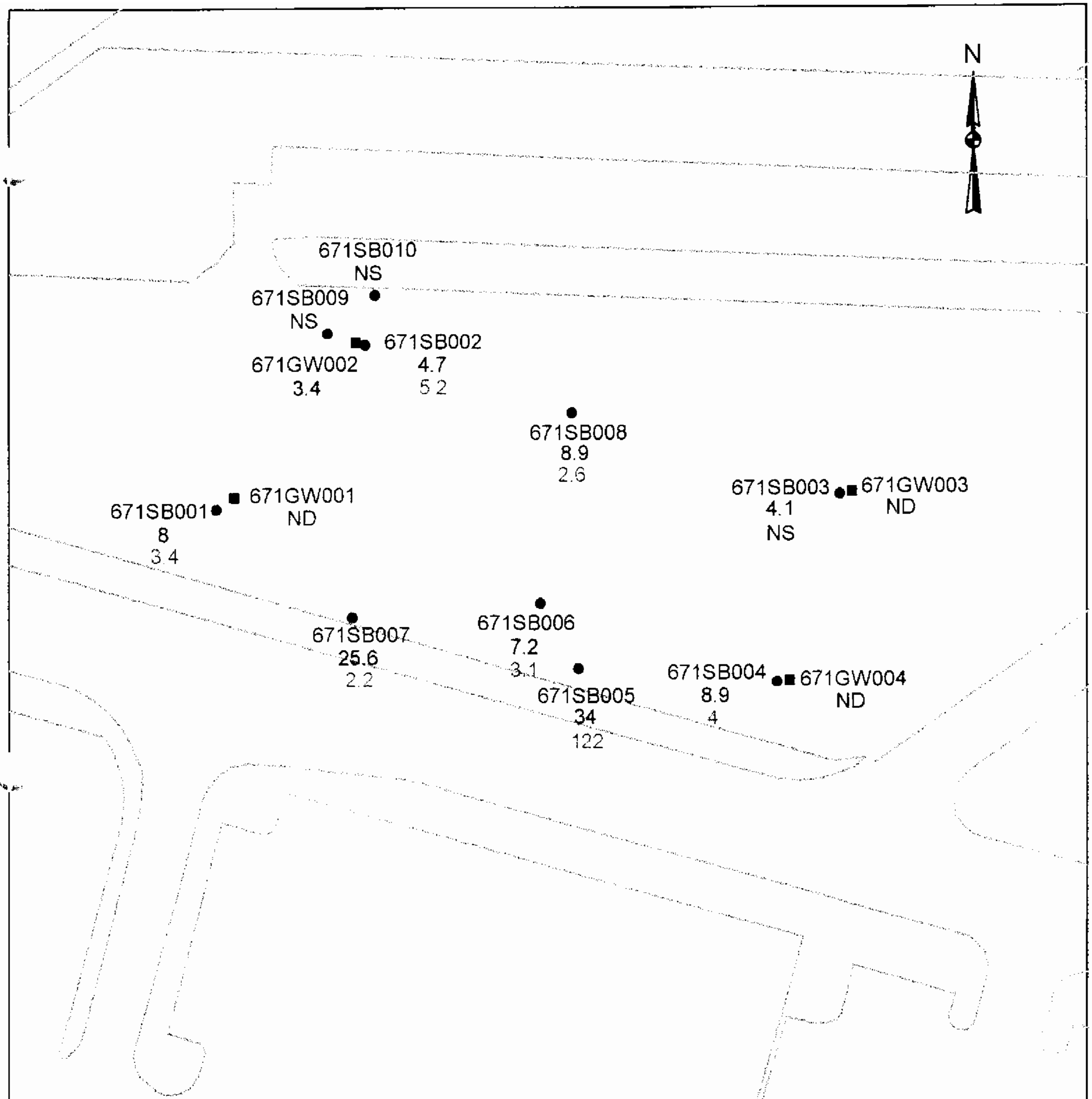
No organic constituents were present in groundwater at concentrations exceeding the applicable screening levels. Three inorganic constituents were present in groundwater at levels that exceeded the applicable RBCs: arsenic, mercury, and thallium. In addition, arsenic, copper, and mercury were present at concentrations that exceeded their respective surface water criteria. A review of four quarters of sampling indicates that arsenic levels remain essentially unchanged, while the other constituents are present above screening primarily in the fourth-quarter. The consistent concentrations of arsenic point to a stable flux into the system, most likely naturally occurring (the point of departure for arsenic is 23 μg/L). Conversely, the inconsistent occurrence of the other inorganics points to an unstable flux, and may reflect climatologically induced variable water quality or sampling/analytical error. Further sampling may be required to resolve the source of these inconsistencies. As for surface-water migration, groundwater flow is consistent with the discharge to the Cooper River; consequently, this pathway has some merit and should be considered. The degree of significance will depend on the dilutional capacity of the system, however. As for the risk-based pathway, the groundwater in the surficial aquifer is not currently used for consumption, nor is it anticipated to be in the future, thus eliminating the receptor and invalidating this pathway.

No VOCs were detected at AOC 671. As a result, the soil-to-air migration pathway is not considered valid at AOC 671.

10.1.6 Human Health Risk Assessment

10.1.6.1 Site Background and Investigative Approach

The purpose of the investigation at AOC 671 was the assessment of soil and groundwater potentially affected by past activities onsite. AOC 671 includes the former Metering House,



LEGEND

■	MONITORING WELL LOCATION
●	ZONE I SOIL BORING LOCATION
12.30	ZONE I SURFACE SOIL CONC. (MG/KG)
12.30	ZONE I SUBSURFACE SOIL CONC. (MG/KG)
12.30	MAXIMUM QUARTERLY GW CONC. (UG/L)
NS	NO SAMPLE TAKEN
ND	NON DETECT

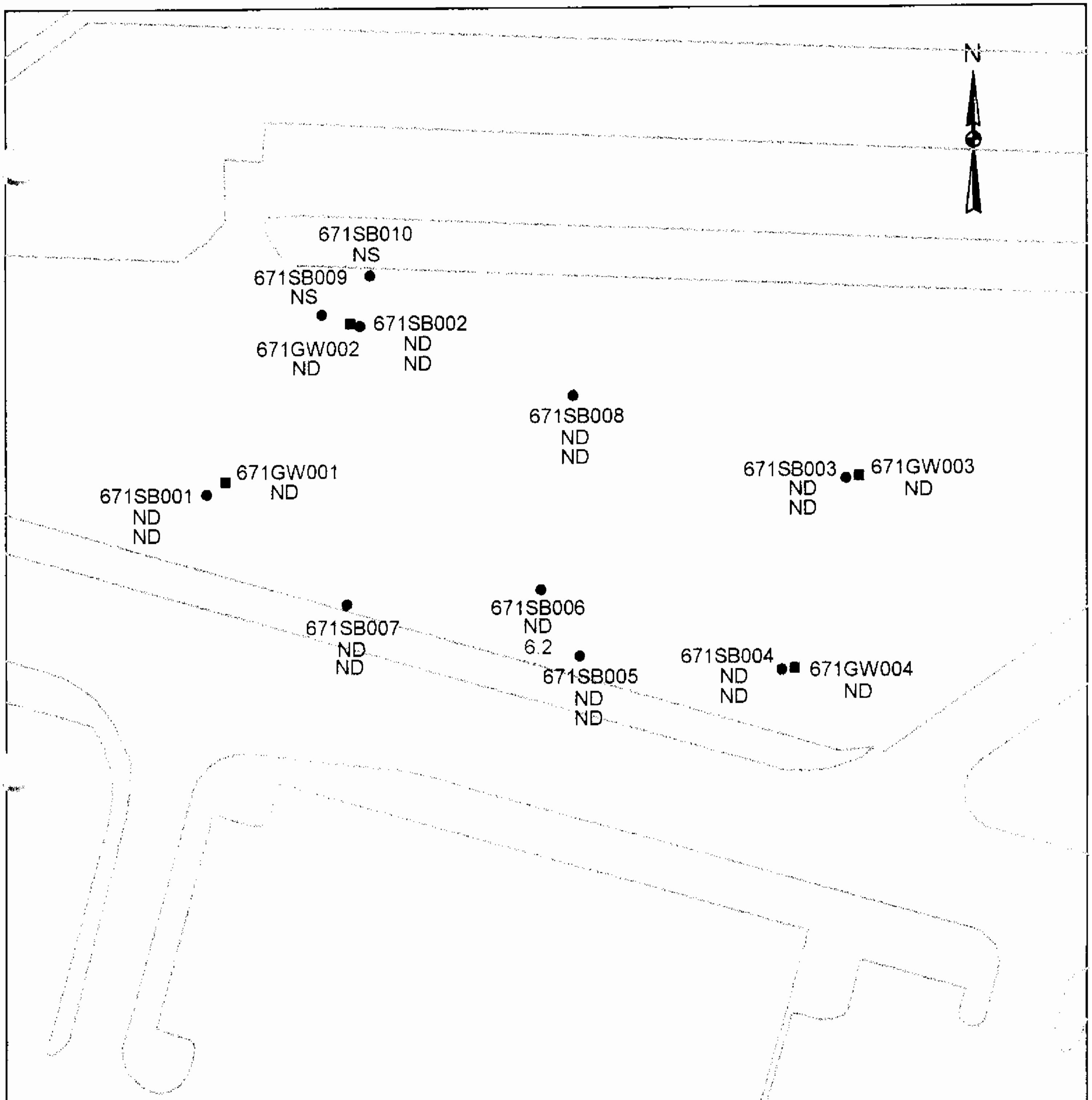
SCALE

40 0 40 80 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.1.12
ZONE I
AOC 671
COPPER
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=1300 UG/L RBC=310 MG/KG SSL=5600 MG/KG



LEGEND

■ MONITORING WELL LOCATION
● ZONE I SOIL BORING LOCATION
12.30 ZONE I SURFACE SOIL CONC. (MG/KG)
12.30 ZONE I SUBSURFACE SOIL CONC. (MG/KG)
12.30 MAXIMUM QUARTERLY GW CONC. (UG/L)
NS NO SAMPLE TAKEN
ND NON DETECT

SCALE
40 0 40 80 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.1.8
ZONE I
AOC 671
ANTIMONY
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=6 UG/L RBC=3.1 MG/KG SSL=2.7 MG/KG

Building 3905G, and the two associated 25,000 gallon USTs. The tanks were constructed in 1944 and used to store aviation gasoline until 1966. The area is currently an unused asphalt parking lot. Two raised circular areas in the asphalt are believed to represent the locations of the USTs. The lack of information regarding the possible removal of these USTs and the surface expression suggest the USTs are still in place. No previous investigations or remedial actions have been documented for AOC 671.

Two rounds of soil sampling were performed at AOC 671. The locations are shown on Figure 10.1.1. Eight proposed upper-interval samples were collected and seven of the eight proposed lower-interval soil samples were collected. One lower-interval sample was not collected because the water table was encountered at less than 5 ft. bgs. All first-round samples were analyzed at DQO Level III for VOCs, SVOCs, pesticides/PCBs, cyanide, and metals. Two samples selected as duplicates were analyzed at DQO Level IV for Appendix IX analytical parameters. Four first-round soil borings (upper and lower-intervals) were analyzed for organotins. Two additional second-round samples were collected to determine the extent of pesticides detected in the initial sampling. Surface soil samples from all boring locations were used to quantitatively assess soil exposure pathways. Subsurface soil is addressed in Section 10.1.5, Fate and Transport Assessment.

To characterize the site groundwater, four shallow monitoring wells were installed and sampled during four-rounds in accordance with the final RFI work plan. Monitoring well locations were previously shown on Figure 10.1.1. During the first round of sampling, AOC 671 wells were sampled for VOC, SVOC, metals, cyanide, pesticides, and PCBs, chloride, sulfate, and TDS at DQO Level III. Samples from rounds two and three were analyzed for metals, cyanide, and pesticides and PCBs. Fourth-round samples were analyzed for metals, cyanide, pesticides, and PCBs, chloride, sulfate, and TDS. Data from the four sampling rounds for each well were used to quantitatively assess groundwater exposure pathways.

10.1.6.2 COPC Identification

Soil

Based on the screening comparisons described in Section 7 of this RFI and presented in Table 10.1.10, this Human Health Risk Assessment (HHRA) focus on the following COPCs: benzo(a)pyrene equivalents and N-Nitroso-di-n-propylamine. Aluminum, arsenic, and manganese were detected at maximum concentrations exceeding their RBCs, but not background concentrations. Therefore, these inorganics were eliminated from further consideration in the AOC 671 HHRA. Wilcoxon rank sum test analyses did not result in the inclusion of any inorganic parameters that had been screened out on the basis of background concentration.

Groundwater

As shown in Table 10.1.11, arsenic, mercury, and thallium were identified as COPCs in shallow groundwater at AOC 671. Manganese was detected at a maximum concentration exceeding its RBC and was initially excluded from the list of COPCs since its maximum concentration did not exceed its background concentration. However, manganese was identified as having concentrations consistently higher than background based on the results of Wilcoxon rank sum test analysis and was therefore included as a COPC. Wilcoxon rank sum test did not identify any other CPSSs that had been screened out on the basis of background comparisons only.

10.1.6.3 Exposure Assessment

Exposure Setting

AOC 671 is the site of a former metering house and aviation gasoline compound that operated from the 1940s to the 1960s. The area is currently an unused parking lot. Current base reuse plans indicate that the area is slated for redevelopment as a marine cargo terminal.

Table 10.1.10
Chemicals Present in Site Samples
AOC 671 - Surface Soil
Charleston Naval Complex
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration Residential RBC	Reference	Units	Number Exceeding RBC	Reference
Carcinogenic PAHs													
Benzo(a)pyrene Equivalents	*	1	8	1090	1090	1090	1400	1800	87	NA	µG/KG	1	
Benzo(a)anthracene	*	1	8	1600	1600	1600	730	920	870	NA	µG/KG	1	
Benzo(a)pyrene	*	1	8	690	690	690	730	920	87	NA	µG/KG	1	
Benzo(b)fluoranthene	*	1	8	1270	1270	1270	860	1100	870	NA	µG/KG	1	
Benzo(k)fluoranthene		1	8	1420	1420	1420	690	860	8700	NA	µG/KG		
Chrysene		1	8	1305	1305	1305	600	750	87000	NA	µG/KG		
Dibenz(a,h)anthracene		1	8	70	70	70	480	600	87	NA	µG/KG		
Indeno(1,2,3-cd)pyrene		1	8	260	260	260	510	640	870	NA	µG/KG		
Inorganics													
Aluminum (Al)		8	8	3870	12900	7810	NA	NA	7800	27400	MG/KG	4	
Arsenic (As)		7	8	1.5	8.3	5.49	2.9	2.9	0.43	21.6	MG/KG	7	
Barium (Ba)		8	8	10.2	20.8	15.7	NA	NA	550	54.2	MG/KG		
Beryllium (Be)		4	8	0.34	0.72	0.46	0.25	0.41	16	0.95	MG/KG		
Cadmium (Cd)		1	8	0.5	0.5	0.5	0.08	0.61	7.8	0.61	MG/KG		
Calcium (Ca)	N	8	8	7150	45800	23225	NA	NA	NA	NA	MG/KG		
Chromium (Cr)		8	8	10.6	22.7	17.5	NA	NA	39	34.5	MG/KG		
Cobalt (Co)		7	8	1.9	4.8	2.66	1.8	1.9	470	5.8	MG/KG		
Copper (Cu)		8	8	4.1	34	12.7	NA	NA	310	240	MG/KG		
Iron (Fe)	N	8	8	4260	13600	7360	NA	NA	NA	NA	MG/KG		
Lead (Pb)		8	8	6.1	39.8	19.9	NA	NA	400	203	MG/KG		
Magnesium (Mg)	N	8	8	589	2240	1280	NA	NA	NA	NA	MG/KG		
Manganese (Mn)		8	8	44.9	213	83.2	NA	NA	160	419	MG/KG	1	
Mercury (Hg)		1	8	0.26	0.26	0.26	0.11	0.16	2.3	0.47	MG/KG		
Nickel (Ni)		8	8	3.3	8.8	5.93	NA	NA	160	23.9	MG/KG		
Potassium (K)	N	3	8	1130	1400	1240	522	973	NA	NA	MG/KG		
Selenium (Se)		2	8	0.32	0.56	0.44	0.3	0.67	39	1.49	MG/KG		
Sodium (Na)	N	7	8	217	647	349	567	567	NA	NA	MG/KG		
Thallium (Tl)		2	8	0.33	0.39	0.36	0.3	0.83	0.55	ND	MG/KG		
Tin (Sn)		2	8	1.4	9.5	5.45	0.92	7.2	4700	7.5	MG/KG		1
Vanadium (V)		8	8	8.1	29.5	18.4	NA	NA	55	113	MG/KG		

Table 10.1.10
Chemicals Present in Site Samples
AOC 671 - Surface Soil
Charleston Naval Complex
Charleston, South Carolina

Parameter	Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration Residential RBC	Screening Concentration Reference	Units	Number Exceeding RBC	Number Exceeding Reference
Zinc (Zn)	8	8	19.7	73.7	38.1	NA	NA	2300	206	MG/KG		
Pesticides												
4,4'-DDD	6	10	4.8	430	86.4	1.9	25	2700	NA	µG/KG		
4,4'-DDE	5	10	120	490	278	1.9	5.5	1900	NA	µG/KG		
4,4'-DDT	3	10	9.5	21	15.5	1.9	25	1900	NA	µG/KG		
alpha-BHC	1	10	0.17	0.17	0.17	0.53	7	100	NA	µG/KG		
beta-BHC	1	10	20	20	20	0.53	7	350	NA	µG/KG		
delta-BHC	1	10	0.59	0.59	0.59	0.53	7	350	NA	µG/KG		
Dieldrin	2	10	0.19	4.6	2.40	1.7	11	40	NA	µG/KG		
Endosulfan I	2	10	1.9	2.6	2.25	0.8	11	47000	NA	µG/KG		
Endosulfan sulfate	2	10	0.33	0.55	0.44	2.2	14	47000	NA	µG/KG		
Endrin	2	10	0.14	2.7	1.42	0.05	17	2300	NA	µG/KG		
Endrin aldehyde	3	10	0.78	2.1	1.49	0.53	7	2300	NA	µG/KG		
Heptachlor epoxide	2	10	7.9	8.7	8.3	0.53	1.6	70	NA	µG/KG		
Semivolatile Organics												
Acenaphthene	1	8	975	975	975	730	920	470000	NA	µG/KG		
Anthracene	1	8	3020	3020	3020	820	1000	2300000	NA	µG/KG		
Benzo(g,h,i)perylene	1	8	235	235	235	690	860	310000	NA	µG/KG		
Dibenzofuran	1	8	1225	1225	1225	770	960	31000	NA	µG/KG		
Di-n-butylphthalate	3	8	98	230	143	740	1200	780000	NA	µG/KG		
Fluoranthene	3	8	38	6400	2170	1000	1300	310000	NA	µG/KG		
Fluorene	1	8	2160	2160	2160	770	960	310000	NA	µG/KG		
1-Methylnaphthalene	1	8	110	110	110	1200	1700	310000	NA	µG/KG		
2-Methylnaphthalene	1	8	58	58	58	930	1300	310000	NA	µG/KG		
Naphthalene	1	8	59	59	59	730	1000	310000	NA	µG/KG		
N-Nitroso-di-n-propylamine *	1	8	340	340	340	680	950	91	NA	µG/KG	1	
Phenanthrene	1	8	8900	8900	8900	690	860	230000	NA	µG/KG		
Pyrene	2	8	57	4300	2179	810	1000	230000	NA	µG/KG		

Table 10.1.10
Chemicals Present in Site Samples
AOC 671 - Surface Soil
Charleston Naval Complex
Charleston, South Carolina

Parameter	Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration Residential RBC	Screening Concentration Reference	Units	Number Exceeding RBC	Number Exceeding Reference
Volatile Organics												
Acetone	3	8	21	31	26.7	31	130	780000	NA	µG/KG		
Acetonitrile	1	8	130	130	130	220	310	47000	NA	µG/KG		
Toluene	5	8	2	13	4.7	21	23	1600000	NA	µG/KG		
Organotins												
Tetrabutyltin	3	4	5.88	117.2	49.4	3.3	3.3	2300	NA	µG/KG		
TCDD Equivalents												
Dioxin	2	2	0.213	2.1	1.16	NA	NA	4.3	NA	NG/KG		

Notes:
* - Indicates chemical was identified as a COPC.
N - Indicates chemical is an essential nutrient.
SQL - Sample quantitation limit
RBC - Risk-based concentration
µG/KG - micrograms per kilogram
MG/KG - milligrams per kilogram
NA - Not applicable or not available
ND - Not determined due to lack of information

Table 10.1.11
Chemicals Present in Site Samples
AOC 671 - Shallow Groundwater
Charleston Naval Complex
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration Tap Water RBC	Reference	Units	Number Exceeding RBC	Reference
Aluminum (Al)		4	16	47.45	172	95.2	18	97.0	3700	1440	µG/L		
Arsenic (As)	*	9	16	9.5	42	22	3.2	10	0.045	23	µG/L	9	4
Barium (Ba)		12	16	15.4	22.5	19.1	12.1	19.5	260	110	µG/L		
Beryllium (Be)		1	16	0.485	0.485	0.485	0.2	1	7.3	1.1	µG/L		
Cadmium (Cd)		3	16	0.3	0.65	0.417	0.3	1	1.8	NA	µG/L		
Calcium (Ca)	N	16	16	101000	144000	121250	NA	NA	NA	NA	µG/L		
Chromium (Cr)		5	16	0.9	1.2	1.01	0.8	4.9	18	14.3	µG/L		
Copper (Cu)		1	16	3.4	3.4	3.4	0.6	3.9	150	4.4	µG/L		
Iron (Fe)	N	16	16	493	4730	2781	NA	NA	NA	NA	µG/L		
Lead (Pb)		5	16	2	7.7	4.48	1.7	3	15	4.4	µG/L		2
Magnesium (Mg)	N	16	16	46200	112000	72356	NA	NA	NA	NA	µG/L		
Manganese (Mn)		16	16	467	1000	707	NA	NA	73	5430	µG/L	16	
Mercury (Hg)	*	1	16	37.9	37.9	37.9	0.1	0.23	1.1	NA	µG/L	1	
Nickel (Ni)		2	16	1	1.5	1.25	0.8	3	73	13.3	µG/L		
Potassium (K)	N	15	16	30400	81400	49060	80000	80000	NA	NA	µG/L		
Sodium (Na)	N	16	16	90600	746000	356288	NA	NA	NA	NA	µG/L		
Thallium (Tl)	*	2	16	5.5	6.6	6.05	2.7	5	0.26	2	µG/L	2	2
Vanadium (V)		7	16	0.55	1.5	1.07	0.5	2	26	14	µG/L		
Zinc (Zn)		6	16	3.8	10.2	6.38	4	5.3	1100	24.4	µG/L		

Notes:
* - Indicates chemical was identified as a COPC
N - Indicates chemical is an essential nutrient
SQL - Sample quantitation limit
RBC - Risk-based concentration
µg/L - micrograms per liter
NA - Not applicable or not available

Since municipal water is readily available basewide, it is highly unlikely that the aquifer will be used as a source of potable or process water. Groundwater exposure pathways would not be completed if the municipal water supply is kept in place. As a highly conservative estimate of potential risk/hazard due to groundwater pathways, a residential scenario and an industrial scenario were considered for AOC 671.

Potentially Exposed Populations

Potentially exposed populations are current and future site workers, hypothetical future site residents, and adolescent trespassers. Future site resident and worker exposure scenarios were addressed quantitatively in this risk assessment. Current exposure to workers is discussed quantitatively in relation to the future workers and future residents. The hypothetical future site worker scenario assumed continuous exposure to surface soil conditions. Current site workers' exposure would be less than that assumed for the hypothetical future site worker scenario because of their limited soil contact (the pavement would prevent direct contact to the site). Therefore, future worker assessment is considered to conservatively represent current site workers. The resident child scenario was considered to conservatively represent of the adolescent trespasser. The future site resident scenario was built on the premise that existing features would be removed and replaced with dwellings.

Exposure Pathways

Exposure pathways for the hypothetical future site residents are dermal contact and incidental ingestion of surface soils. The exposure pathways for future site workers are the same as those for the future site residents with respect to soil. The groundwater pathway for the hypothetical future site residents and site workers is incidental ingestion of groundwater. Uniform exposure was assumed for all sample locations. No VOCs were reported in AOC 671 groundwater samples at concentrations exceeding residential RBCs; therefore, the inhalation of volatiles pathway was not addressed for this site. Table 10.1.12 presents the justification for exposure pathways assessed in this HHRA.

Table 10.1.12
AOC 671
Exposure Pathways Summary

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Current Land Uses			
Current Users (Site Workers)	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	This exposure pathway was considered insignificant compared to the other pathways.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Shallow groundwater is not currently used as a source of potable or non-residential water at AOC 671.
	Shallow groundwater, Inhalation of volatilized shallow groundwater contaminants	No	Shallow groundwater is not currently used as a source of potable or non-residential water at AOC 671.
	Soil, Incidental ingestion	No (Qualified)	Future site use is considered conservatively representative of current site use.
	Soil, Dermal contact	No (Qualified)	Future site use is considered conservatively representative of current site use.
Future Land Uses			
Future Site Residents (Child and Adult), Future Site Worker	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	This exposure pathway was considered insignificant compared to the other pathways.
	Shallow groundwater, ingestion of contaminants during potable or general use	Yes	Shallow groundwater is not likely to be used as a source of potable or non-residential water at AOC 671. This pathway was addressed as a conservative measure.
	Shallow groundwater, Inhalation of volatilized contaminants during domestic use	No	Volatile COPCs were not identified subsequent to risk-based screening comparisons.
	Soil, Incidental ingestion	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.
	Soil, Dermal contact	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.
	Wild game or domestic animals, Ingestion of tissue impacted by media contamination	No	Hunting/taking of game and/or raising livestock is prohibited within the Charleston, South Carolina, city limits.
	Fruits and vegetables, Ingestion of plant tissues grown in media	No	The potential for significant exposure via this pathway is low relative to that of other exposure pathways assessed.

Exposure Point Concentrations

As discussed in Section 7 of this RFI, UCLs are generally calculated for data sets consisting of at least 10 samples. The maximum concentrations of benzo(a)pyrene equivalents and N-nitroso-di-n-propylamine were used as the soil pathway EPCs, because fewer than 10 samples were collected. A "hot spot" approach was used to account for the limited extent of identified impacts. Both COPCs were detected in only one of eight surface soil samples analyzed (671SB002). As a result, it was deemed appropriate to derive a fraction ingested/contacted (FI/FC) factor accounting for the limited areal extent of the contaminants in surface soil. This factor was conservatively estimated to be 0.2, indicating that the concentration reported at 671SB002 was representative of soil quality for more than 20% of the potential exposure area. The FI/FC factor was used to adjust the EPC for benzo(a)pyrene equivalents and N-nitroso-di-n-propylamine.

Table 10.1.13 summarizes the determination of the groundwater EPC. Four shallow monitoring wells were originally installed at this site and sampled once a quarter for four quarters. Current EPA guidance favors the arithmetic mean in the most concentrated area of the plume as the EPC for groundwater COPCs. Groundwater COPCs cannot be associated with a single distinct plume.

Instead, each COPC was assigned to its own "plume". In each case, a separate plume is defined by the monitoring well which produced the highest concentration for a given COPC. The EPC is calculated as the arithmetic mean of the four quarters of data from the same well. For example, the maximum arsenic detection (0.042 mg/L) was from monitoring well 671003 sampled during the second quarter. The first-quarter sample from this monitoring well had arsenic at a concentration of 0.0314 mg/L, the third-quarter sample from this monitoring well had an arsenic concentration of 0.0288 mg/L, and the fourth-quarter sample was 0.0389 mg/L. The data from the four quarters (0.0314, 0.042, 0.0288, and 0.0389 mg/L) yield an average of 0.0353 mg/L, which was used as the EPC for arsenic. This same approach was used for thallium, manganese and mercury.

Table 10.1.13
Statistical Analysis of COPCs
Shallow Groundwater
AOC 671
Charleston Naval Complex
Charleston, South Carolina

COPC	n	Natural Log Transformed mean	SD	H-stat	Mean in Plume (mg/L)	UCL (mg/L)	MAX (mg/L)	EPC (mg/L)	
Arsenic	16	-4.884775148	1.162299	2.98	0.0353	0.036	0.042	0.036	UCL
Thallium	16	-5.984875676	0.397254	1.955	0.0035	0.003	0.0066	0.0035	MEAN
Mercury	16	-8.922838371	1.525235	3.608	0.0096	0.0018	0.0379	0.0096	MEAN
Manganese	16	-0.362685729	0.185164	1.794	0.8035	0.7712	1.0	0.8035	MEAN

Notes:
mean arithmetic mean of the logtransformed data
n number of samples analyzed
SD standard deviation for a sample of data
H-stat "H" statistic from Gilbert 1987; cuboidal interpolation was used to determine the value in accordance with *USEPA Supplemental Guidance to RAGS, Calculating the Concentration* Term.
EPC exposure point concentration
UCL 95 percentile upper confidence level mean
MAX maximum reported concentration

Quantification of Exposure

Soil

CDIs for ingestion and dermal contact with soils are shown in Tables 10.1.14 and 10.1.15, respectively.

Groundwater

CDIs for the groundwater pathway are shown in Table 10.1.16.

10.1.6.4 Toxicity Assessment

Toxicity assessment terms and methods are discussed in Section 7 of this report. Table 10.1.17 presents toxicological information specific to each COPC identified at AOC 671. This information was used in the quantification of risk/hazard associated with soil and groundwater contaminants. A brief toxicological profile for each COPC is provided in the following paragraphs.

Arsenic exposure via the ingestion route causes darkening and hardening of the skin in chronically exposed humans. Inhalation exposure to arsenic causes neurological deficits, anemia, and cardiovascular effects (Klaasen, et al., 1986). USEPA set 0.3 μg/kg-day as the RfD for arsenic based on a NOAEL of 0.8 μg/kg-day in a human exposure study. Arsenic's effects on the nervous and cardiovascular systems are primarily associated with acute exposure to higher levels. Exposure to arsenic-containing materials has been shown to cause cancer in humans. Inhalation of these materials can lead to increased lung cancer risk, and ingestion of these materials is associated with increased skin cancer rates. Arsenic has been classified as a group A carcinogen by USEPA, which established the 1.5 $(mg/kg\text{-}day)^{-1}$ SF. As listed in IRIS, the basis for the classification is sufficient evidence from human data. An increased lung cancer mortality was observed in multiple human populations exposed primarily through inhalation. Also, increased mortality from multiple internal organ cancers (liver, kidney, lung, and bladder) and an increased incidence of skin cancer were observed in populations consuming drinking water high in inorganic

Table 10.1.14
Chronic Daily Intakes
Incidental Ingestion of Surface Soil
AOC 671
Charleston Naval Complex
Charleston, South Carolina

Chemical	Fraction Ingested from Contaminated Source *	Exposure Point Concentration (mg/kg)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident LWA C-CDI (mg/kg-day)	Future Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Benzo(a)pyrene Equivalents	0.2	1.1	3.00E-07	2.80E-06	3.43E-07	1.07E-07	3.83E-08
N-Nitroso-di-n-propylamine	0.2	0.34	9.32E-08	8.69E-07	1.06E-07	3.33E-08	1.19E-08

Notes:
LWA Lifetime-weighted average; used to calculate carcinogenic CDI, RAGS Parts A and B.
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
* Reflects the estimated fraction of the site impacted by the corresponding COPC.
mg/kg Milligram per kilogram
mg/kg-day Milligram per kilogram per day

Table 10.1.15
Chronic Daily Intakes
Dermal Contact with Surface Soil
AOC 671
Charleston Naval Complex
Charleston, South Carolina

Chemical	Exposure Point Concentration (mg/kg)	Fraction Contacted from Contaminated Source *	Dermal Absorption Factor+ (unitless)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident LWA C-CDI (mg/kg-day)	Future Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Benzo(a)pyrene Equivalents	1.1	0.2	0.01	1.23E-07	4.06E-07	7.70E-08	8.79E-08	3.14E-08
N-Nitroso-di-n-propylamine	0.34	0.2	0.01	3.82E-08	1.26E-07	2.39E-08	2.73E-08	9.74E-09

Notes:
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
+ The dermal absorption factor was applied to the exposure point concentration to reflect the different transdermal migration of inorganic versus organic chemicals.
* Reflects the estimated fraction of the site impacted by the corresponding COPC.
LWA Lifetime-weighted average

Table 10.1.16
Chronic Daily Intakes
Ingestion of COPCs in Shallow Groundwater
AOC 671
Charleston Naval Complex
Charleston, South Carolina

Chemical	Exposure Point Concentration (mg/liter)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident LWA C-CDI (mg/kg-day)	Future Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Arsenic	0.036	9.95E-04	2.32E-03	5.47E-04	3.55E-04	1.27E-04
Thallium	0.0035	9.49E-05	2.21E-04	5.22E-05	3.39E-05	1.21E-05
Mercury	0.0096	2.62E-04	6.11E-04	1.44E-04	9.34E-05	3.34E-05
Manganese	0.8035	2.20E-02	5.14E-02	1.21E-02	7.86E-03	2.81E-03

Notes:

LWA	Lifetime-weighted average
CDI	Chronic Daily Intake
H-CDI	Non-carcinogenic hazard based Chronic Daily Intake
C-CDI	Carcinogenic risk based Chronic Daily Intake
mg/liter	Milligrams per liter
mg/kg/day	Milligrams per kilogram per day

Table 10.1.17
Toxicological Reference Information
for Chemicals of Potential Concern
AOC 671
Charleston Naval Complex
Charleston, South Carolina

	Non-Carcinogenic Toxicity Data								*Carcinogenic Toxicity Data*			
Chemical	**Oral Reference Dose (mg/kg-day)**	**Confidence Level**	**Critical Effect**	**Uncertainty Factor Oral**	**Inhalation Reference Dose (mg/kg-day)**	**Confidence Level**	**Critical Effect**	**Uncertainty Factor Inhalation**	**Oral Slope Factor (kg-day/mg)**	**Inhalation Slope Factor (kg-day/mg)**	**Weight of Evidence**	**Tumor Type**
Arsenic	0.0003 a	M	hyperpigmentation	3	NA	NA	NA	NA	1.5 a	15.1 a	A	various
Benzo(a)pyrene Equivalents	NA	NA	NA	NA	NA	NA	NA	NA	7.3 a	3.1 b	B2	mutagen
Manganese (food)	0.14 a	M	neurological effects	1	1.43E-05 a	M	neurological effects	1000	NA	NA	D	NA
Manganese (water)	0.02 a	M	neurological effects	1	1.43E-05 a	M	neurological effects	1000	NA	NA	D	NA
Mercury	0.0003 a	H	Autoimmune effects	1,000	8.60E-05	M	Autoimmune Disfunction	30	NA	NA	D	NA
N-Nitroso-di-n-propylamine	NA	NA	NA	NA	NA	NA	NA	NA	7 a	NA	B2	various
Thallium	7E-05 c	L	increased SGOT (liver) increased serum LDH	3000	NA	NA	NA	NA	NA	NA	D	NA

Notes:

a = Integrated Risk Information System (IRIS)
b = Withdrawn from IRIS/HEAST
c = RfDo for thallium sulfate corrected for the difference in molecular weight between thallium and thallium sulfate
NA = Not applicable or not available
L = Low confidence
M = Medium confidence
H = High confidence
mg/kg/day = Milligrams per kilogram per day
kg-day/mg = Kilograms per day per milligrams

arsenic. Human milk contains about 3 μg/L arsenic. The tap-water RBC for arsenic is 0.045 μg/L. As listed in IRIS, the critical effect of this chemical is hyperpigmentation, keratosis, and possible vascular complications. The uncertainty factor was determined to be 3 and the modifying factor was determined to be 1.

Benzo(a)pyrene equivalents include the following polynuclear aromatic hydrocarbons (PAHs):

Benzo(a)anthracene	TEF 0.1
Benzo(b)fluoranthene	TEF 0.1
Benzo(k)fluoranthene	TEF 0.01
Benzo(a)pyrene	TEF 1.0
Chrysene	TEF 0.001
Dibenz(a,h)anthracene	TEF 1.0
Indeno(1,2,3-cd)pyrene	TEF 0.1

Some PAHs are toxic to the liver, kidney, and blood. However, the toxic effects of the PAHs above have not been well established. There are no RfDs for these PAHs due to a lack of data. All PAHs listed above are classified by USEPA as B2 carcinogens, and their carcinogenicity is addressed relative to that of benzo(a)pyrene, which has an oral SF of 7.3 (mg/kg-day)$^{-1}$. TEFs, also set by USEPA, are multipliers applied to the detected concentrations, which are subsequently used to calculate excess cancer risk. These multipliers are discussed further in the exposure and toxicity assessment sections. Most carcinogenic PAHs have been classified as such due to animal studies using large doses of purified PAHs. There is some doubt as to the validity of these listings, and the SFs listed in USEPA's RBC table are provisional. However, these PAHs are carcinogens when the exposure involves a mixture of other carcinogenic substances (e.g., coal tar, soot, cigarette smoke). As listed in IRIS, human data specifically linking benzo(a)pyrene to a carcinogenic effect are lacking. There are, however, multiple animal studies in many species demonstrating benzo(a)pyrene to be carcinogenic by numerous routes.

Benzo(a)pyrene has produced positive results in numerous genotoxicity assays. At the June 1992 CRAVE Work Group meeting, a revised risk estimate of benzo(a)pyrene was verified. This section provides information on three aspects of the carcinogenic risk assessment for the agent in question: the USEPA classification and quantitative estimates of exposure. The classification reflects a weight-of-evidence judgment of the likelihood that the agent is a human carcinogen. The quantitative risk estimates are presented in application of a low-dose extrapolation procedure and presented as the risk per mg/kg-day. The unit risk is the quantitative estimate in terms of either risk per μg/L drinking water or risk per $\mu g/m^3$ air breathed. The third form, in which risk is presented, is drinking water or air concentration providing cancer risks of 1 in 10,000 or 1 in 1,000,000. The carcinogenicity background document provides details on the carcinogenicity values found in IRIS. Users are referred to the Oral Reference Dose and Reference Concentration sections for information on long-term toxic effects other than carcinogenicity.

As listed in IRIS, the basis for the dibenz(a,h)anthracene and benzo(b)fluoranthene B2 classification is no human data and sufficient data from animal bioassays. Benzo(b)fluoranthene produced tumors in mice after lung implantation, intraperitoneal or subcutaneous injection, and skin painting. As listed in IRIS, the basis for the benzo(a)anthracene B2 classification is no human data and sufficient data from animal bioassays. Benzo(a)anthracene produced tumors in mice exposed by gavage; intraperitoneal, subcutaneous or intramuscular injection; and topical application. Benzo(a)anthracene produced mutations in bacteria and in mammalian cells, and transformed mammalian cells in culture. As listed in IRIS, the basis for the benzo(k)fluoranthene B2 classification is no human data and sufficient data from animal bioassays. Benzo(k)fluoranthene produced tumors after lung implantation in mice and when administered with a promoting agent in skin-painting studies. Equivocal results have been found in a lung adenoma assay in mice. Benzo(k)fluoranthene is mutagenic in bacteria. (Klaasen, et al., 1986).

Mercury occurs in three forms: elemental, organic, and inorganic. The major source of this element is the degassing of the earth's crust. Target organs of inorganic mercury include the kidney, nervous system, fetus, and neonate. In other words, this inorganic can be toxic to a fetus if the mother is exposed during pregnancy. Mercury is toxic to all cells in the body – it binds to enzymes in the cells and disrupts their function, usually causing the cell to be useless or die. Because this inorganic is concentrated in the kidney prior to excretion, the kidney is a major target organ for mercury ingestion. The primary target of mercury vapor is the brain. Some forms of mercury are drawn toward fats in the body (such as the nervous system), where the form is changed into its toxic form. This causes the nervous disorder known as Minimata disease, which results from overexposure to mercury through ingestion of contaminated fish. The fish ingested inorganic mercury from an industrial discharge, and the inorganic form was metabolized to organic mercury. USEPA set mercury's RfD to 0.0003 mg/kg-day (inorganic form) and its inhalation RfC is 8E-05 mg/kg-day (elemental form). Mercury is liquid at room temperature, and is poorly absorbed in this form if ingested. Typical daily exposure is less than 1 μg/1-day (Klaasen, et al., 1986; Dreisbach, et al., 1987).

Manganese is an essential nutrient, but chronic exposure (0.8 mg/kg-day) causes mental disturbances. Studies have shown that manganese uptake from water is greater than manganese uptake from food, and the elderly appear to be more sensitive than children (Klaasen et al., 1986); Dreisbach et al., 1987). USEPA determined the RfD to be 0.14 mg/kg-day based on dietary uptake. USEPA recommended using a modifying factor of 3 when estimating intake from soil and water. In addition, the body roughly absorbs twice as much manganese in water as it does manganese in food. Because of the different uptake rates in water and food, two RfDs were used in this HHRA – one for water and one for food. The RfDs used are 0.047 and 0.023 mg/kg-day, respectively. Inhalation of manganese dust causes neurological effects and increased incidence of pneumonia. An inhalation RfD was set to 1.43E-05 mg/kg-day. According to USEPA, manganese cannot be classified as to its carcinogenicity. Therefore, its cancer class is group D. As listed in IRIS, this classification is based on studies that are inadequate to assess the carcinogenicity of manganese. Manganese is considered essential to human health, the typical vitamin supplement dose is 2.5 mg/day. As listed in IRIS, the critical effects of this chemical in water in the oral summary are CNS effects. The uncertainty factor was 1 and the recommended modifying factor of 3 was used to estimate soil and groundwater intake. This chemical critically affects the CNS. As listed in IRIS, its critical effect in the inhalation summary neuro behavioral is impairment. For inhalation uptake, the uncertainty factor was 1,000 and the modifying factor was 1. The IRIS RfC is 5E-05 mg/m^3.

N-Nitroso-di-n-propylamine is a USEPA B2 carcinogen. This semivolatile organic compound was determined to be a carcinogen in two species and a mutagen. As listed in IRIS, the basis for the classification is increased tumor incidence at multiple sites in two rodent species and in monkeys administered the compound by various routes. The respiratory system and liver were determined to be the primary sites for cancer caused by this compound. USEPA determined the SF to be 7.0 (mg/kg-day)$^{-1}$.

Thallium is readily absorbed through the gut and skin. Primary effects are stomach and bowel disturbances, kidney and liver damage, and neurological disturbances. Thallium was used in the past as a rodenticide and ant killer, uses now prohibited. This element remains in the body for a relatively long time, and could accumulate if the chronic dose is large. USEPA's RfD for thallium is 0.00008 mg/kg-day (Klaasen, et al., 1986; Dreisbach, et al., 1987). The uncertainty factor for thallium is 3,000.

10.1.6.5 Risk Characterization

Surface Soil Pathways

Exposure to surface soil onsite was evaluated under both residential and industrial (site worker) scenarios. For these scenarios, the incidental ingestion and dermal contact exposure pathways were evaluated. For noncarcinogenic contaminants evaluated for future site residents, hazard was computed separately to address child and adult exposure. Tables 10.1.18 and 10.1.19 present the computed carcinogenic risks and/or HQs associated with incidental ingestion of and dermal contact with site surface soils, respectively.

Hypothetical Site Residents

The ingestion ILCR (based on the adult and child lifetime-weighted average) for AOC 671 surface soil is 3E-06. The dermal pathway ILCR is 1E-06. Benzo(a)pyrene equivalents were the primary contributor for each pathway. No noncarcinogenic COPCs were identified in AOC 671 surface soil; thus, no hazard indices were computed.

Future Site Workers

Site worker ILCRs are 4E-07 and 6E-07 for the ingestion and dermal contact pathways, respectively. No noncarcinogenic COPCs were identified in AOC 671 surface soil; thus, no hazard indices were computed.

The entire AOC 671 area is an asphalt parking lot near Pier Q. Current site users have little chance of exposure to affected surface soil. Location 671SB002 is beneath an asphalt surface. As a result, the risk/hazard projections discussed above are considered gross overestimates, should existing site features be maintained under future-use scenarios.

Table 10.1.18
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
AOC 671
Charleston Naval Complex
Charleston, South Carolina

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used $(mg/kg\text{-}day)^{-1}$	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident LWA ILCR	Future Worker adult Hazard Quotient	Future Worker adult ILCR
Benzo(a)pyrene Equivalents	NA	7.3	ND	ND	2.5E-06	ND	2.8E-07
N-Nitroso-di-n-propylamine	NA	7	ND	ND	7.5E-07	ND	8.3E-08
SUM Hazard Index/ILCR			ND	ND	3E-06	ND	4E-07

Notes:
NA Not available
ND Not Determined due to lack of available information
LWA Lifetime-weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

Table 10.1.19
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
AOC 671
Charleston Naval Complex
Charleston, South Carolina

Chemical	Dermal Adjustment*	Oral RfD Used (mg/kg-day)	Oral SF Used $(mg/kg\text{-}day)^{-1}$	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident LWA ILCR	Future Worker adult Hazard Quotient	Future Worker adult ILCR
Benzo(a)pyrene Equivalents	0.5	NA	14.6	ND	ND	1.1E-06	ND	4.6E-07
N-Nitroso-di-n-propylamine	0.5	NA	14	ND	ND	3.3E-07	ND	1.4E-07
SUM Hazard Index/ILCR				ND	ND	1E-06	ND	6E-07

Notes:

NA Not available
ND Not determined due to lack of available information
LWA Lifetime-weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A.
ILCR Incremental Lifetime Cancer Risk
* Dermal to absorbed dose adjustment factor is applied to adjust for oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI).

Groundwater Pathways

Exposure to shallow groundwater onsite was evaluated under both residential and site worker scenarios. The ingestion exposure pathway was evaluated assuming the site groundwater will be used for potable and/or domestic purposes and that an unfiltered well, drawing from the corresponding water-bearing zone, will be installed. For noncarcinogenic contaminants evaluated relative to future site residents, hazard was computed separately for child and adult receptors. Table 10.1.20 presents the risk and hazard for the ingestion pathway. Since no VOCs were identified as COPCs in groundwater at AOC 671, the inhalation pathway was not addressed at this site.

Hypothetical Site Residents

Arsenic is the sole contributor to ILCR projections associated with the groundwater ingestion pathway. The ILCR for the future residential scenario is 8E-04. The hazard indices for the adult and child resident are 7 and 15, respectively. Arsenic, thallium, mercury, and manganese were primary contributors to HI projections for the ingestion pathway.

Future Site Workers

The groundwater pathway risk for the site worker scenario is 2E-04 and the hazard index is 2. Arsenic was the sole contributor to ILCR projections and the primary contributor to HI projections for the groundwater ingestion pathway.

Current Site Workers

Shallow groundwater is not currently used as a potable water source for AOC 671 or other Zone I areas. In the absence of a completed exposure pathway, no threat to human health is posed by reported shallow groundwater quality.

Table 10.1.20
Hazard Quotients and Incremental Lifetime Cancer Risks
Shallow Groundwater Ingestion
AOC 671
Charleston Naval Complex
Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used $(mg/kg\text{-}day)^{-1}$	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident LWA ILCR	Future Worker adult Hazard Quotient	Future Worker adult ILCR
Arsenic	0.0003	1.5	3.3	7.7	8.2E-04	1.2	1.9E-04
Thallium	7E-05	NA	1.4	3.2	NA	0.5	NA
Mercury	0.0003	NA	0.9	2.0	NA	0.3	NA
Manganese	0.023	NA	1.0	2.2	NA	0.3	NA
SUM Hazard Index/ILCR			7	15	8E-04	2	2E-04

Notes:

NA	Not available
LWA	Lifetime-weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR	Incremental Lifetime Cancer Risk
mg/kg/day	Milligram per kilogram per day

COCs Identified

Identification of chemicals of concern was based on cumulative (all pathway) risk and hazard projected for this site. USEPA has established a generally acceptable risk range of 1E-04 to 1E-06, and a hazard index threshold of 1.0 (unity). As recommended by SCDHEC, a COC was considered to be any chemical contributing to a cumulative risk level of 1E-06 or greater and/or a cumulative hazard index above 1.0, if its individual ILCR exceeds 1E-06 or its hazard quotient exceeds 0.1. For carcinogens, this approach is relatively conservative because a cumulative risk level of 1E-04 (and individual ILCR of 1E-06) is recommended by USEPA Region IV as the trigger for establishing COCs. The COC selection method was used to more comprehensively evaluate chemicals contributing to carcinogenic risk or noncarcinogenic hazard during remedial goal options development. Table 10.1.21 summarizes the COCs identified for AOC 671 surface soil and groundwater.

Future Site Residents

Surface Soil

Benzo(a)pyrene equivalents were identified as COCs for this scenario based on their contribution to cumulative residential ILCR projections.

No COCs were identified in AOC 671 surface soil based on contribution to cumulative residential HI projections.

Future Site Workers

No COCs were identified for this scenario based on the cumulative ILCR and hazard index projections.

Table 10.1.21
Summary of Risk and Hazard-based COCs
AOC 671
Charleston Naval Complex
Charleston, South Carolina

Medium	Exposure Pathway		Future Resident Adult Hazard Quotient	Future Resident Child Hazard Quotient	Future Resident LWA ILCR	Current Site Worker Hazard Quotient	Current Site Worker ILCR	Identification of COCs			
Surface Soil	Incidental Ingestion	Benzo(a)pyrene Equivalents	ND	ND	2.5E-06	ND	2.8E-07		2		
		N-Nitroso-di-n-propylamine	ND	ND	7.5E-07	ND	8.3E-08				
	Dermal	Benzo(a)pyrene Equivalents	ND	ND	1.1E-06	ND	4.6E-07		2		
		N-Nitroso-di-n-propylamine	ND	ND	3.3E-07	ND	1.4E-07				
Surface Soil Pathway Sum			ND	ND	5E-06	ND	1E-06				
Groundwater	Ingestion	Arsenic	3.3	7.7	8.2E-04	1.2	1.9E-04	1	2	3	4
		Thallium	1.4	3.2	ND	0.48	ND	1		3	
		Mercury	0.9	2.0	ND	0.31	ND	1		3	
		Manganese	1.0	2.2	ND	0.34	ND	1		3	
Groundwater Pathway Sum			7	15	8E-04	2	2E-04				
Sum of All Pathways			7	15	8E-04	2	2E-04				

Notes:
ND indicates not determined due to the lack of available risk information.
ILCR indicates incremental excess lifetime cancer risk
LWA lifetime-weighted average
1- Chemical is a COC by virtue of projected child residence noncarcinogenic hazard.
2- Chemical is a COC by virtue of projected future resident lifetime ILCR.
3- Chemical is a COC by virtue of projected site worker noncarcinogenic hazard.
4- Chemical is a COC by virtue of projected site worker ILCR.

The extent of the COC identified in surface soil is briefly discussed below. Because it was reported at only one location, it is apparent that impact to surface soil was extremely limited. The FI/FC factor of 0.2 was conservatively estimated based on the distance between sampling points and the total potential exposure area. Asphaltic materials directly overlie location 671SB002. Although sampling methods attempted to preclude or minimize asphaltic materials in the borehole, it is possible that these materials could have served as a source of cPAHs if fragments were entrained in underlying soil during boring advancement.

Groundwater

Future Site Residents

Arsenic was identified as a groundwater pathway COC based on its contribution to cumulative residential ILCR projections. Arsenic, mercury, manganese, and thallium were identified as groundwater pathway COCs based on their contribution to cumulative residential HI projections.

Future Site Workers

Arsenic was identified as a groundwater pathway COC based on its contribution to cumulative industrial ILCR projections. Arsenic, mercury, manganese, and thallium were identified as groundwater pathway COCs based on their contribution to cumulative industrial HI projections.

Arsenic was detected at a concentration exceeding its tap-water RBC (0.045 μg/L) in nine groundwater samples. Four samples exceeded Arsenic's background value (23 μg/L). Its maximum reported concentration did not, however, exceed its MCL of 50 μg/L. Mercury was detected at a concentration exceeding its tap-water RBC (1.1 μg/L) and its MCL (2 μg/L) in one fourth-quarter groundwater sample (671003). Manganese was detected at a concentration exceeding its tap-water RBC (73 μg/L) in all 16 groundwater samples. No samples exceeded the background value (5,430 μg/L) for manganese. Thallium was detected at a concentration exceeding its tap-water RBC and MCL in two fourth-quarter groundwater samples. In samples 671001 and 671003, thallium exceeded its RBC of 0.26μg/L and its MCL (2 μg/L).

10.1.6.6 Risk Uncertainty

Characterization of Exposure Setting and Identification of Exposure Pathways

The potential for high bias is introduced through the exposure setting and pathway selection due to the highly conservative assumptions (i.e., future residential use) recommended by USEPA Region IV when assessing potential future and current exposure. The exposure assumptions made in the site worker scenario are highly protective and would tend to overestimate exposure. The area impacted by COPCs is covered by an asphalt surface, which precludes exposure to affected surface soil. Current site workers are not exposed to site groundwater.

Residential use of the site would not be expected, based on current site uses and the nature of surrounding buildings. Current reuse plans call for continued commercial/industrial use of Zone I, specifically as a marine cargo terminal. If this area were to be used as a residential site, the current buildings would be demolished, asphalt surface removed, and the surface soil conditions would likely change — the soils could be covered with landscaping soil, and/or houses. Consequently, exposure to current surface soil conditions would not be likely under a true future residential scenario. These factors indicate that exposure pathways assessed in this HHRA would generally overestimate the risk and hazard posed to current site workers and future site residents.

Shallow groundwater is not currently used at AOC 671 for potable or industrial purposes. A basewide system provides drinking and process water to buildings throughout Zone I. This system is slated to remain in operation under the current base reuse plan. As a result, shallow groundwater would not be expected to be used under future site use scenarios. Therefore, the screening scenario established for this site associated with shallow groundwater exposure is highly conservative, and associated pathways are not expected to be completed in the future.

Determination of Exposure Point Concentrations

No UCLs were calculated for COPCs in surface soil because fewer than 10 samples were analyzed for identified COPCs. The maximum concentration of benzo(a)pyrene equivalents and N-nitroso-di-n-propylamine were applied as the EPC and modified in accordance with the "hot spot" approach.

The 95% UCLs or arithmetic means of the detected concentrations were applied as the EPCs for groundwater COPCs. Region IV guidance states that the average concentration of each COPC in the most concentrated area of the plume should be used as the EPC. Since a plume cannot be readily defined, this guidance applies only marginally. Groundwater data variability contributes greatly to uncertainty through spatial variability. Ninety-five percent UCLs were calculated to provide point estimates for groundwater to account for this uncertainty, thus providing an upper bound estimate for modeling exposure. For any given COPC, the placement of monitoring wells in uncontaminated areas of the aquifer could cause a low bias on the 95% UCL. As a result, the arithmetic mean of detected concentrations in the most concentrated plume area was compared to the 95% UCL and the larger value was selected as the EPC. To address any uncertainty regarding the method used to calculate groundwater EPCs, risk/hazard maps were included in the risk summary section. The maps also provide additional perspective.

Frequency of Detection and Spatial Distribution

Surface Soil

Benzo(a)pyrene equivalents and N-nitroso-di-n-propylamine were detected in only one of eight surface soil samples collected (671SB002). This sample was collected north of the western UST at AOC 671, directly beneath an asphalt surface. As a result, it was deemed appropriate to derive FI/FC accounting for the limited areal extent of the contaminants in surface soil. This factor was conservatively estimated to be 0.2, indicating that the concentrations reported at 671SB002 were representative of soil quality for more than 20% of the potential exposure area. The FI/FC factor was used to adjust the EPC for both compounds. The fraction ingested from contaminated source was considered in the exposure calculations at AOC 671. It is based on the spatial distribution and frequency of detection for each COPC. Further sampling in the area of the surface soil location reported to be impacted would likely serve to further reduce the FI/FC factor, and thus exposure estimates.

Groundwater

Arsenic exceeded its tap-water RBC in nine groundwater samples. The four quarterly samples from well 671003 exceeded the background value established for arsenic. Mercury exceeded its tap-water RBC and MCL in one well (671003). Manganese exceeded its tap-water RBC, but was below background in all 16 groundwater samples. Thallium was detected in two samples from the fourth-quarter sampling event. These two concentrations exceeded thallium's tap-water RBC and MCL.

Quantification of Risk/Hazard

As indicated by the discussions above, the uncertainty inherent in the risk assessment process is great. In addition, many site-specific factors that have affected the uncertainty of this assessment would upwardly bias the risk and hazard estimates. Exposure pathway-specific sources of uncertainty are discussed below.

Soil

Of the CPSSs screened and eliminated from formal assessment, none was reported at a concentration within 10% of its RBC. This minimizes the likelihood of potentially significant cumulative risk/hazard based on the eliminated CPSSs. Concentrations of aluminum, arsenic, and manganese exceeded their RBCs, but not their background concentrations. Therefore, they were eliminated from formal assessment based on comparisons to corresponding background concentrations.

Central tendency (CT) analysis was not formally performed for AOC 671 surface soil, but a simplified approach was taken to assess the potential influences of CT assumptions. The central tendency assumption for residential exposure duration is nine years compared to the 30 year assumption for the reasonable maximum exposure (RME). The CT exposure frequency assumption is 234 days/year compared to 350 days/year RME. If all other exposure assumptions remain fixed, application of the CT exposure duration and frequency would result in risk projections 80% below the RME. At CT, the residential surface soil pathway-related risk (incidental ingestion and dermal contact) would drop from 5E-06 to 1E-06.

Although AOC 671s future land use is unknown, both the worker and residential exposure scenarios were assessed in this HHRA. Current base reuse plans call for conversion of the area to a marine cargo terminal. As previously discussed, it is likely that these scenarios would lead to overestimates of risk and/or hazard.

Groundwater

The same conservative screening process used for soil is also used for groundwater. Of the CPSSs screened and eliminated from formal assessment, none was reported at concentrations close to its RBC (e.g. within 10% of its RBCs).

Groundwater is not currently used as a potable water source at AOC 671, or in the surrounding area. Municipal water is readily available. As mentioned previously, it is highly unlikely that the site will be developed as a residential area, and it is unlikely that a potable-use well would be installed onsite. If residences were constructed onsite and an unfiltered well were installed, it is probable that salinity and dissolved solids would preclude this aquifer from being an acceptable potable water source.

Background-Related Risk

Soil

Aluminum, arsenic, and manganese were detected in AOC 671 surface soil at concentrations exceeding their RBCs. These elements were eliminated from consideration in the risk assessment based on comparison to corresponding background values. It is not unusual for naturally occurring or background concentrations of some elements to exceed risk-based concentrations. It is the risk assessment's function to identify excess risk and/or hazard, or that which exceeds background levels. The following discusses of the residential scenario risk/hazard associated with background concentrations of aluminum and arsenic.

Aluminum: The maximum surface soil concentration of aluminum (12,900 mg/kg) for AOC 671 equates with hazard quotients of 0.2 and 0.009 for the residential child and site worker, respectively. The background value for aluminum (27,400 mg/kg) results in hazard quotients of 0.4 and 0.02 for the residential child and site worker, respectively.

Arsenic: The maximum surface soil concentration of arsenic (8.3 mg/kg) equates with ILCRs of 2E-05 and 3E-06 for the residential and site worker scenarios, respectively. The maximum reported concentration of arsenic equates with hazard quotients of 0.4 and 0.02 for the residential child and site worker, respectively. The background value for arsenic (21.6 mg/kg) equates with ILCRs of 6E-06 and 8E-06, and hazard quotients of 1 and 0.05 for the residential and site worker scenarios, respectively.

Manganese: The maximum surface soil concentration of manganese (213 mg/kg) equates with hazard quotients of 0.06 and 0.01 for the residential child and site workers, respectively. The background value for manganese (419 mg/kg) results in hazard quotients of 0.06 and 0.01 for the residential child and site worker, respectively.

Groundwater

Of the CPSSs screened and eliminated from formal assessment, none was reported at concentrations within 10% of its RBC.

10.1.6.7 Risk Summary

The risk and hazard posed by contaminants at AOC 671 were assessed for the future site worker and the future site resident under reasonable maximum exposure assumptions. In surface soils, the incidental ingestion and dermal contact pathways were assessed in this HHRA. The ingestion pathway was assessed for groundwater. Table 10.1.22 summarizes risk for each pathway/receptor group evaluated for AOC 671.

Soil — Residential Scenario

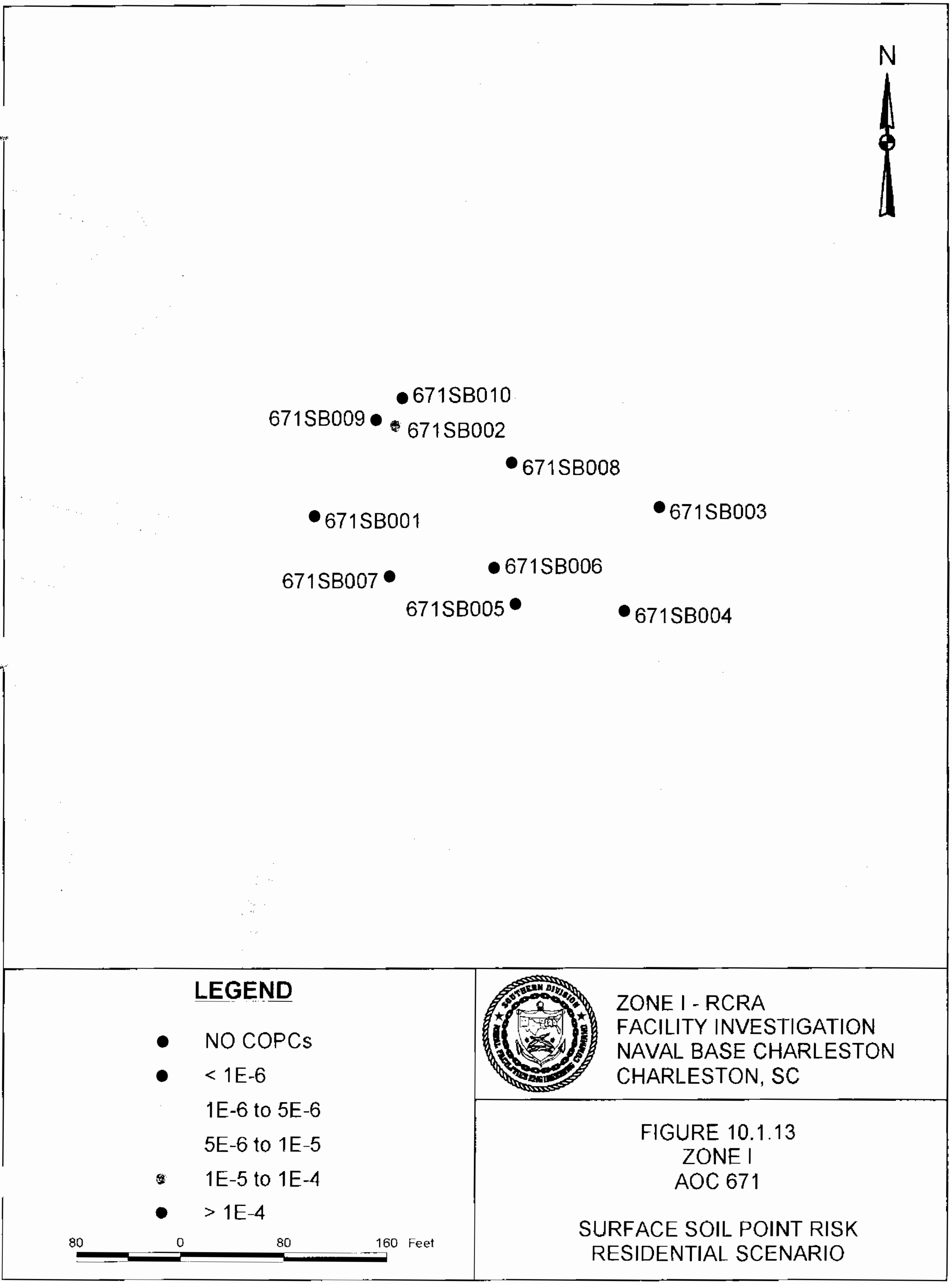
The residential soil pathway COCs identified for AOC 671 are BEQs. Figures 10.1.13 and 10.1.14 illustrate point risk and hazard estimates for AOC 671 based on surface soil exposure pathways under a future residential scenario. Table 10.1.23 summarizes the risk and hazard contribution of each COPC at each sample location. This point risk map (Figure 10.10.13) is based on the unlikely assumption that a potential future site resident will be chronically exposed to specific points. Exposure to surface soil conditions is more likely the result of uniform exposure to the soil conditions of the entire site (or exposure unit area) rather than specific points. With this in mind, risk maps supplemented by the tables are useful because they allow the reader to visualize how chemicals driving risk estimates are spatially distributed across the site.

Only one sample location yielded ILCRs that were greater than 1E-06 (671002). Benzo(a)pyrene equivalents were the primary contributors to risk at 671002 while n-nitroso-di-n-propylamine was a secondary contributor. Noncarcinogenic COCs were not identified for surface soils at AOC 671; therefore, HIs were not calculated.

Table 10.1.22
Summary of Risk and Hazard
AOC 671
Charleston Naval Complex
Charleston, South Carolina

Medium	Exposure Pathway	HI (Adult)	HI (Child)	ILCR (LWA)	HI (Worker)	ILCR (Worker)
Surface Soil	Incidental Ingestion	ND	ND	3E-06	ND	4E-07
	Dermal Contact	ND	ND	1E-06	ND	6E-07
Sum of Surface Soil Pathways		ND	ND	5E-06	ND	1E-06
Groundwater	Ingestion	7	15	8E-04	2	2E-04
Sum of Groundwater Pathways		7	15	8E-04	2	2E-04
Sum of All Pathways		7	15	8E-04	2	2E-04

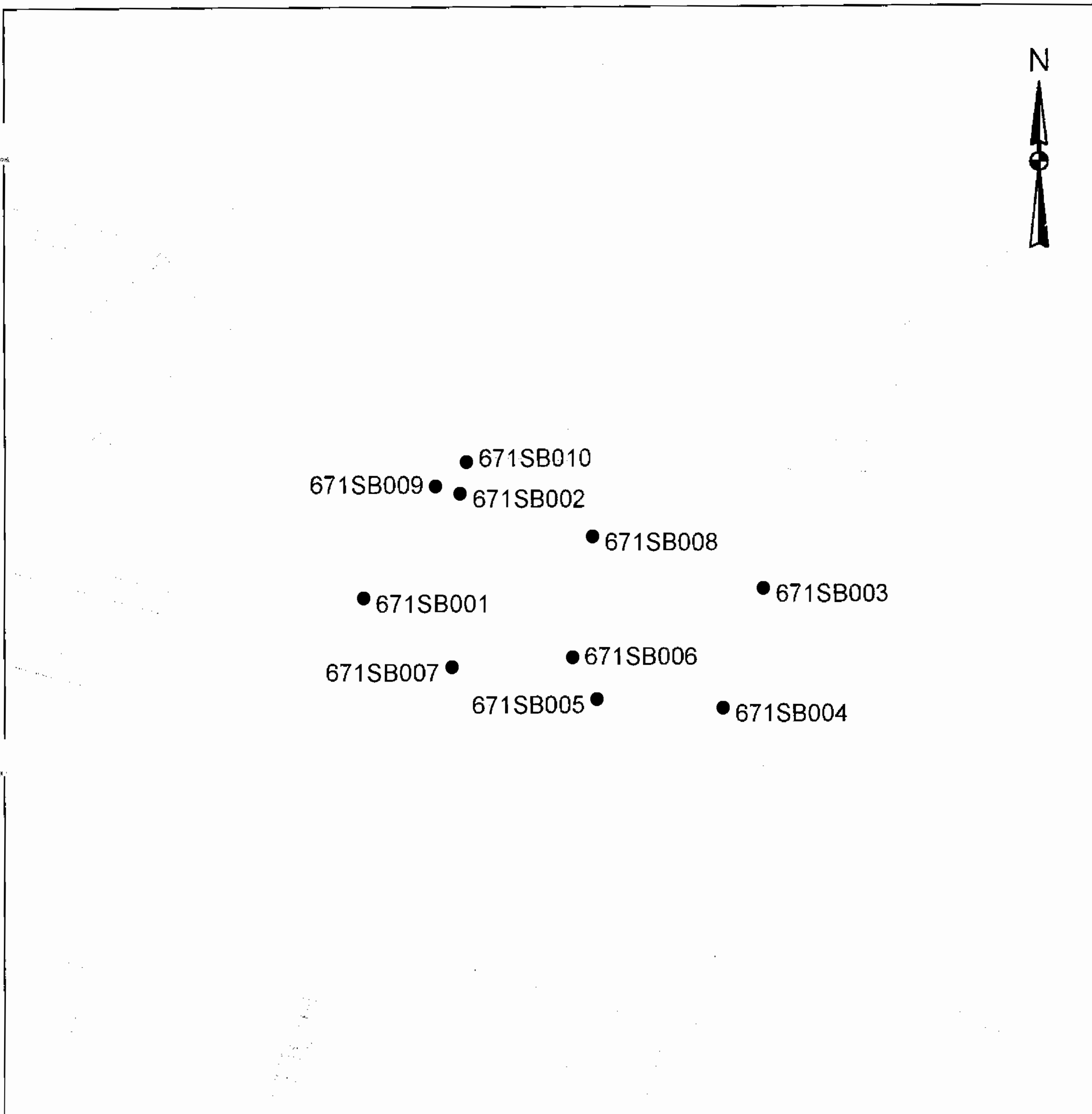
Notes:
ND indicates not determined due to the lack of available risk information.
ILCR indicates incremental lifetime cancer risk
HI indicates hazard index
LWA Lifetime-weighted average



ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.1.13
ZONE I
AOC 671

SURFACE SOIL POINT RISK
RESIDENTIAL SCENARIO



LEGEND

- NO COPCs
- 0 to 0.1
- 0.1 to 0.5
- 0.5 to 1.0
- 1.0 to 3.0
- > 3.0

80 0 80 160 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.1.14
ZONE I
AOC 671

SURFACE SOIL HAZARD INDEX
RESIDENTIAL SCENARIO

Table 10.1.23
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
AOC 671
Charleston Naval Complex
Charleston, South Carolina

AOC	Location	Parameter	Concentration	Units	Hazard Index	Risk (E-06)
671	001	No COPCs			NA	NA
671	002	Benzo(a)pyrene Equivalents	1090	UG/L	NA	18.05
		N-Nitroso-di-n-propylamine	340	UG/L	NA	5.40
				Total	NA	23.45
671	003	No COPCs			NA	NA
671	004	No COPCs			NA	NA
671	005	No COPCs			NA	NA
671	006	No COPCs			NA	NA
671	007	No COPCs			NA	NA
671	008	No COPCs			NA	NA
671	009	No COPCs			NA	NA
671	010	No COPCs			NA	NA

Soil — Site Worker Scenario

No COCs were identified for the site worker soil pathway scenario. Figure 10.1.15 illustrates point risk estimates for AOC 671 based on soil exposure pathways under a future site worker scenario. Table 10.1.24 summarizes the risk and hazard contribution of each COPC at each sample location.

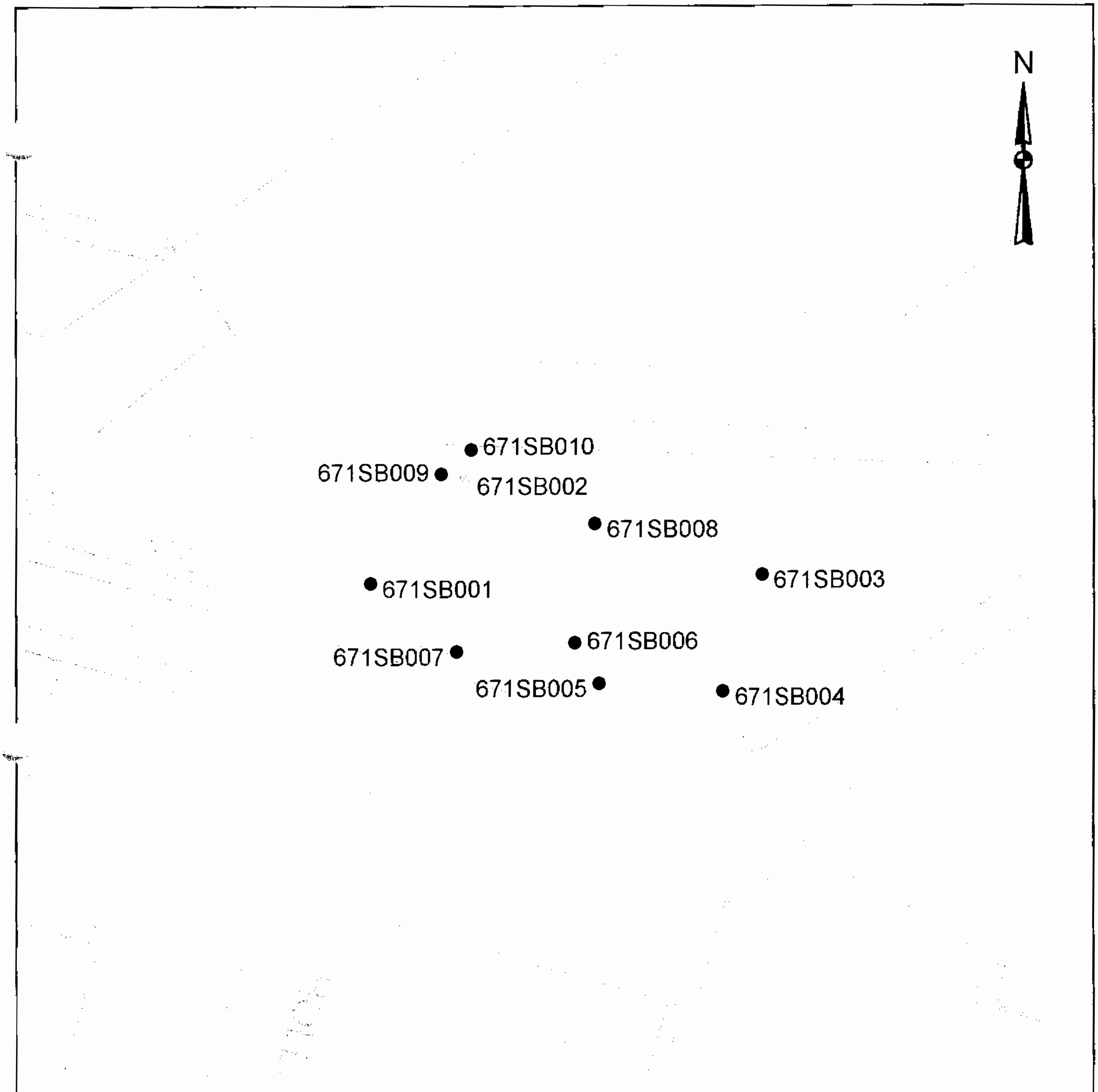
Only one sample location yielded an ILCR greater than 1E-06 (671002). Benzo(a)pyrene equivalents were the primary contributor to risk at 671002, while n-nitroso-di-n-propylamine was a secondary contributor. Noncarcinogenic COCs were not identified in surface soils at AOC 671; therefore HIs were not calculated.

Groundwater — Residential Scenario

Arsenic, manganese, mercury, and thallium were identified as groundwater pathway COCs. As shown in Table 10.1.25 and Figure 10.1.16, arsenic was the sole contributor to risk projections for AOC 671 groundwater pathways. Risk estimates ranged from 2E-04 (67100402) to 9E-04 (67100302), with a mean ILCR of 3E-04. Arsenic, manganese, mercury and thallium were the primary contributors to HI projections. Figure 10.1.17 illustrates point hazard estimates for groundwater for the residential scenario. Hazard estimates ranged from 0.7 (67100203) to 23 (67100304), with a mean hazard index of 5.

Groundwater — Industrial Scenario

Arsenic, mercury, manganese, and thallium were identified as groundwater pathway COCs. As shown in Table 10.1.26 and Figure 10.1.18, arsenic was the sole contributor to risk projections for AOC 671 groundwater. Risk estimates ranged from 1E-04 (67100402) to 4E-04 (67100302), with a mean ILCR of 1E-04. Arsenic, manganese, mercury, and thallium were the primary contributors to HI projections. Figure 10.1.19 illustrates point hazard estimates for groundwater for the industrial scenario. Hazard estimates ranged from 0.5 (67100203) to 7 (67100304), with a mean hazard index of 2.



LEGEND

- NO COPCs
- < 1E-6
- 1E-6 to 5E-6
- 5E-6 to 1E-5
- 1E-5 to 1E-4
- > 1E-4

80 0 80 160 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.1.15
ZONE I
AOC 671

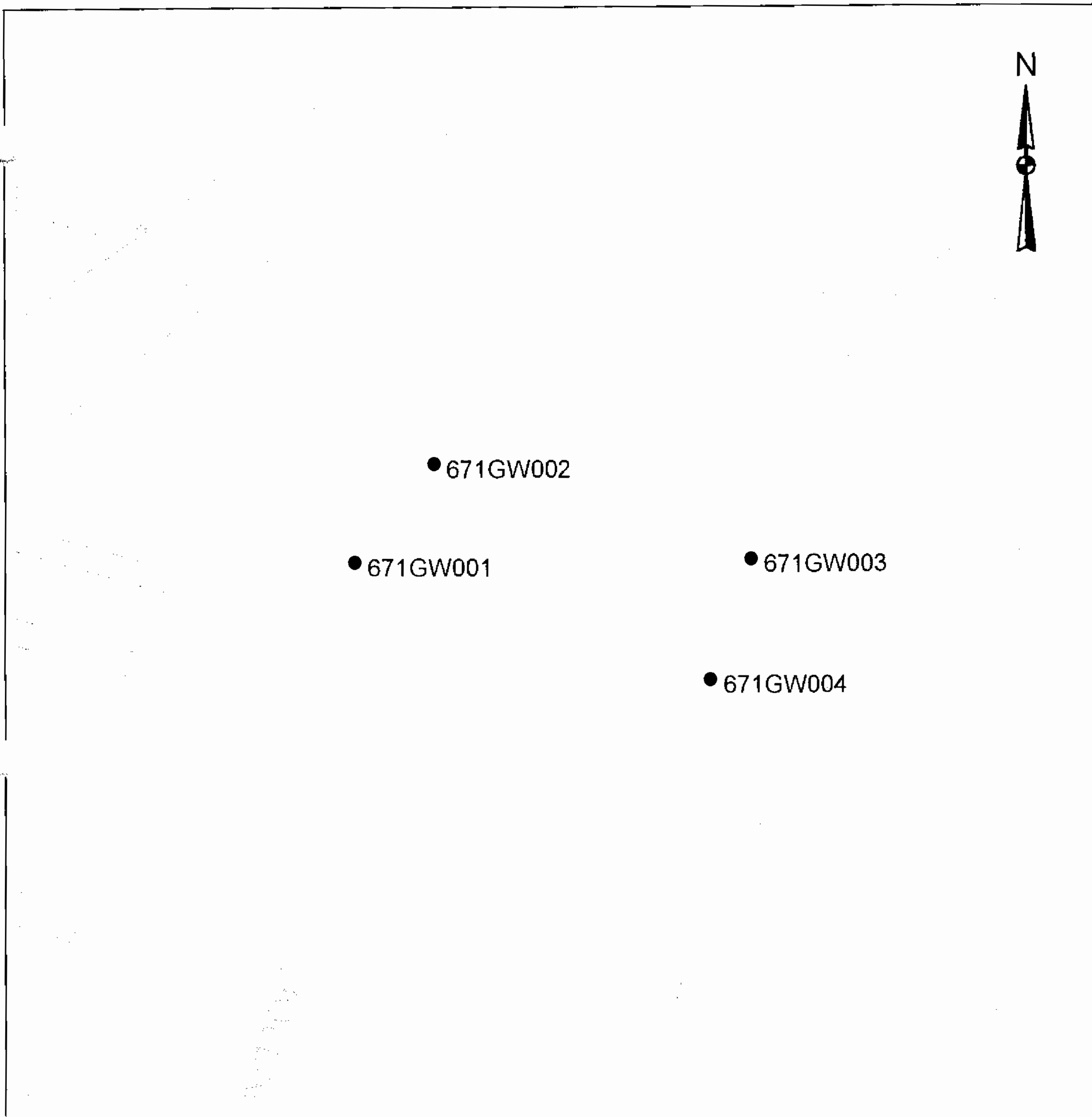
SURFACE SOIL POINT RISK
INDUSTRIAL SCENARIO

Table 10.1.24
Point Estimates of Risk and Hazard - Surface Soil Pathways
Industrial Scenario
AOC 671
Charleston Naval Complex
Charleston, South Carolina

AOC	Location	Parameter	Concentration	Units	Hazard Index	Risk (E-06)
671	001	No COPCs			NA	NA
671	002	Benzo(a)pyrene Equivalents	1090	UG/L	NA	3.67
		N-Nitroso-di-n-propylamine	340	UG/L	NA	1.10
				Total	NA	4.77
671	003	No COPCs			NA	NA
671	004	No COPCs			NA	NA
671	005	No COPCs			NA	NA
671	006	No COPCs			NA	NA
671	007	No COPCs			NA	NA
671	008	No COPCs			NA	NA
671	009	No COPCs			NA	NA
671	010	No COPCs			NA	NA

Table 10.1.25
Point Estimates of Risk and Hazard - Groundwater Pathways
Residential Scenario
AOC 671
Charleston Naval Complex
Charleston, South Carolina

AOC	Location	Round	Parameter	Concentration	Units	Hazard Index	Risk (E-06)
671	001	01	Manganese (Mn)	908	UG/L	1.081	NA
					Total	1.081	NA
671	001	02	Manganese (Mn)	1000	UG/L	1.190	NA
					Total	1.190	NA
671	001	03	Arsenic (As)	10.1	UG/L	2.152	225.32
671	001	03	Manganese (Mn)	666	UG/L	0.793	NA
					Total	2.945	225.32
671	001	04	Thallium (Tl)	5.5	UG/L	4.395	NA
671	001	04	Manganese (Mn)	640	UG/L	0.762	NA
					Total	5.157	NA
671	002	01	Manganese (Mn)	659	UG/L	0.785	NA
					Total	0.785	NA
671	002	02	Manganese (Mn)	671	UG/L	0.799	NA
					Total	0.799	NA
671	002	03	Manganese (Mn)	622	UG/L	0.740	NA
					Total	0.740	NA
671	002	04	Manganese (Mn)	679	UG/L	0.808	NA
					Total	0.808	NA
671	003	01	Arsenic (As)	31.4	UG/L	6.691	700.51
671	003	01	Manganese (Mn)	780	UG/L	0.929	NA
					Total	7.620	700.51
671	003	02	Arsenic (As)	42	UG/L	8.950	936.99
671	003	02	Manganese (Mn)	871	UG/L	1.037	NA
					Total	9.987	936.99
671	003	03	Arsenic (As)	28.8	UG/L	6.137	642.50
671	003	03	Manganese (Mn)	743	UG/L	0.885	NA
					Total	7.022	642.50
671	003	04	Arsenic (As)	38.9	UG/L	8.289	867.83
671	003	04	Mercury (Hg)	37.9	UG/L	8.076	NA
671	003	04	Manganese (Mn)	752	UG/L	0.895	NA
671	003	04	Thallium (Tl)	6.6	UG/L	5.274	NA
					Total	22.535	867.83
671	004	01	Arsenic (As)	17.2	UG/L	3.665	383.72
671	004	01	Manganese (Mn)	668	UG/L	0.795	NA
					Total	4.460	383.72
671	004	02	Arsenic (As)	9.5	UG/L	2.024	211.94
671	004	02	Manganese (Mn)	606.5	UG/L	0.722	NA
					Total	2.746	211.94
671	004	03	Arsenic (As)	9.9	UG/L	2.110	220.86
671	004	03	Manganese (Mn)	467	UG/L	0.556	NA
					Total	2.666	220.86
671	004	04	Arsenic (As)	10.4	UG/L	2.216	232.02
671	004	04	Manganese (Mn)	581	UG/L	0.692	NA
					Total	2.908	232.02



LEGEND

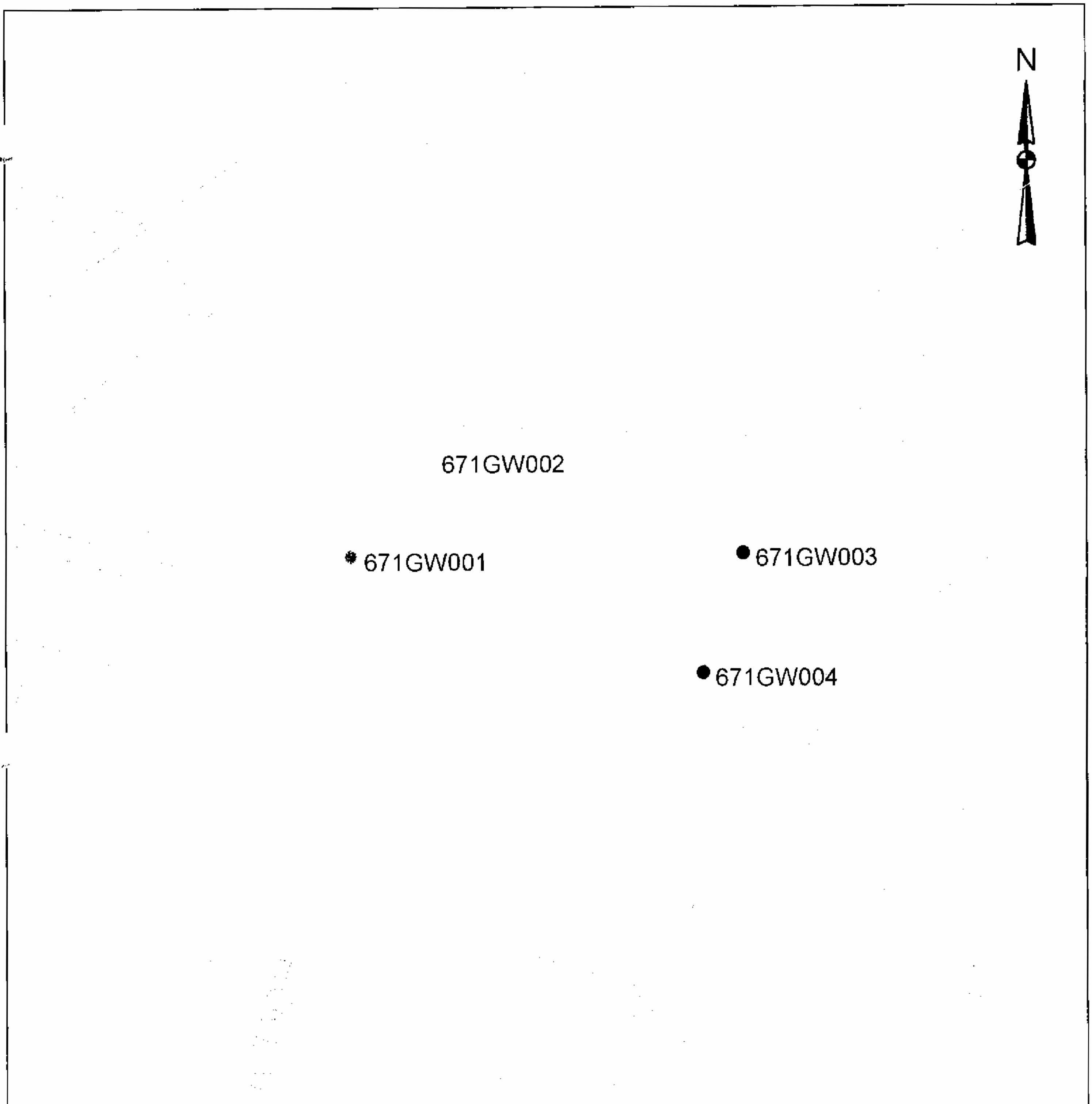
- NO COPCs
- < 1E-6
- 1E-6 to 5E-6
- 5E-6 to 1E-5
- 1E-5 to 1E-4
- > 1E-4

80 0 80 160 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.1.16
ZONE I
AOC 671

GROUNDWATER POINT RISK
RESIDENTIAL SCENARIO



LEGEND

- NO COPCs
- 0 to 0.1
- 0.1 to 0.5
- 0.5 to 1.0
- 1.0 to 3.0
- > 3.0

80 0 80 160 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.1.17
ZONE I
AOC 671

GROUNDWATER HAZARD INDEX
RESIDENTIAL SCENARIO

Table 10.1.26
Point Estimates of Risk and Hazard - Groundwater Pathways
Industrial Scenario
AOC 671
Charleston Naval Complex
Charleston, South Carolina

AOC	Location	Round	Parameter	Concentration	Units	Hazard Index	Risk (E-06)
671	001	01	Manganese (Mn)	908	UG/L	0.773	NA
					Total	0.773	NA
671	001	02	Manganese (Mn)	1000	UG/L	0.851	NA
					Total	0.851	NA
671	001	03	Arsenic (As)	10.1	UG/L	0.659	105.88
671	001	03	Manganese (Mn)	666	UG/L	0.567	NA
					Total	1.226	105.88
671	001	04	Thallium (Tl)	5.5	UG/L	1.345	NA
671	001	04	Manganese (Mn)	640	UG/L	0.545	NA
					Total	1.890	NA
671	002	01	Manganese (Mn)	659	UG/L	0.561	NA
					Total	0.561	NA
671	002	02	Manganese (Mn)	671	UG/L	0.571	NA
					Total	0.571	NA
671	002	03	Manganese (Mn)	622	UG/L	0.529	NA
					Total	0.529	NA
671	002	04	Manganese (Mn)	679	UG/L	0.578	NA
					Total	0.578	NA
671	003	01	Arsenic (As)	31.4	UG/L	2.048	329.19
671	003	01	Manganese (Mn)	780	UG/L	0.664	NA
					Total	2.712	329.19
671	003	02	Arsenic (As)	42	UG/L	2.740	440.31
671	003	02	Manganese (Mn)	871	UG/L	0.741	NA
					Total	3.481	440.31
671	003	03	Arsenic (As)	28.8	UG/L	1.879	301.93
671	003	03	Manganese (Mn)	743	UG/L	0.632	NA
					Total	2.511	301.93
671	003	04	Arsenic (As)	38.9	UG/L	2.538	407.81
671	003	04	Mercury (Hg)	37.9	UG/L	2.472	NA
671	003	04	Manganese (Mn)	752	UG/L	0.640	NA
671	003	04	Thallium (Tl)	6.6	UG/L	1.614	NA
					Total	7.264	407.81
671	004	01	Arsenic (As)	17.2	UG/L	1.122	180.32
671	004	01	Manganese (Mn)	668	UG/L	0.568	NA
					Total	1.690	180.32
671	004	02	Arsenic (As)	9.5	UG/L	0.620	99.59
671	004	02	Manganese (Mn)	606.5	UG/L	0.516	NA
					Total	1.136	99.59
671	004	03	Arsenic (As)	9.9	UG/L	0.646	103.79
671	004	03	Manganese (Mn)	467	UG/L	0.397	NA
					Total	1.043	103.79
671	004	04	Arsenic (As)	10.4	UG/L	0.678	109.03
671	004	04	Manganese (Mn)	581	UG/L	0.494	NA
					Total	1.173	109.03

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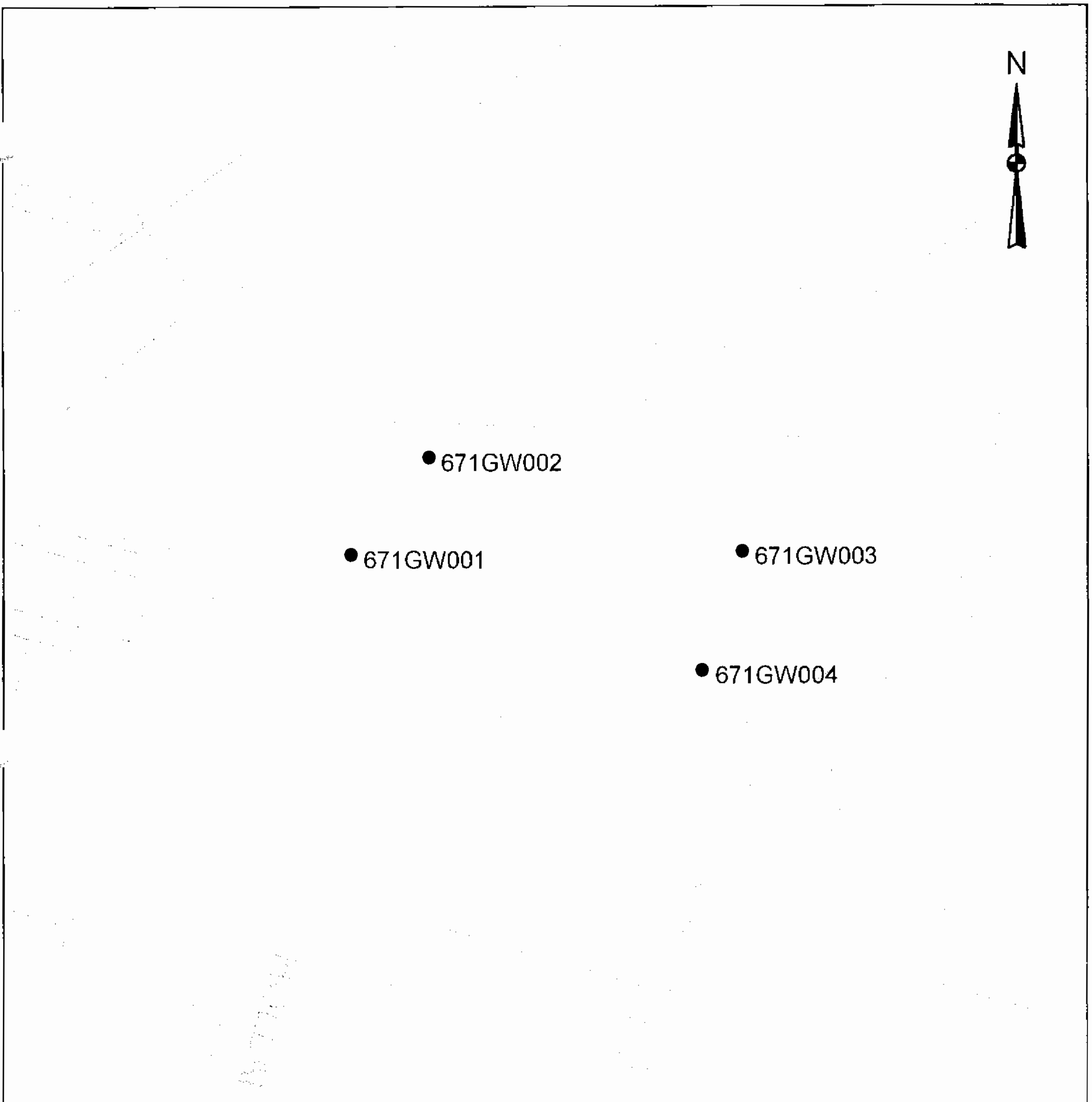


LEGEND

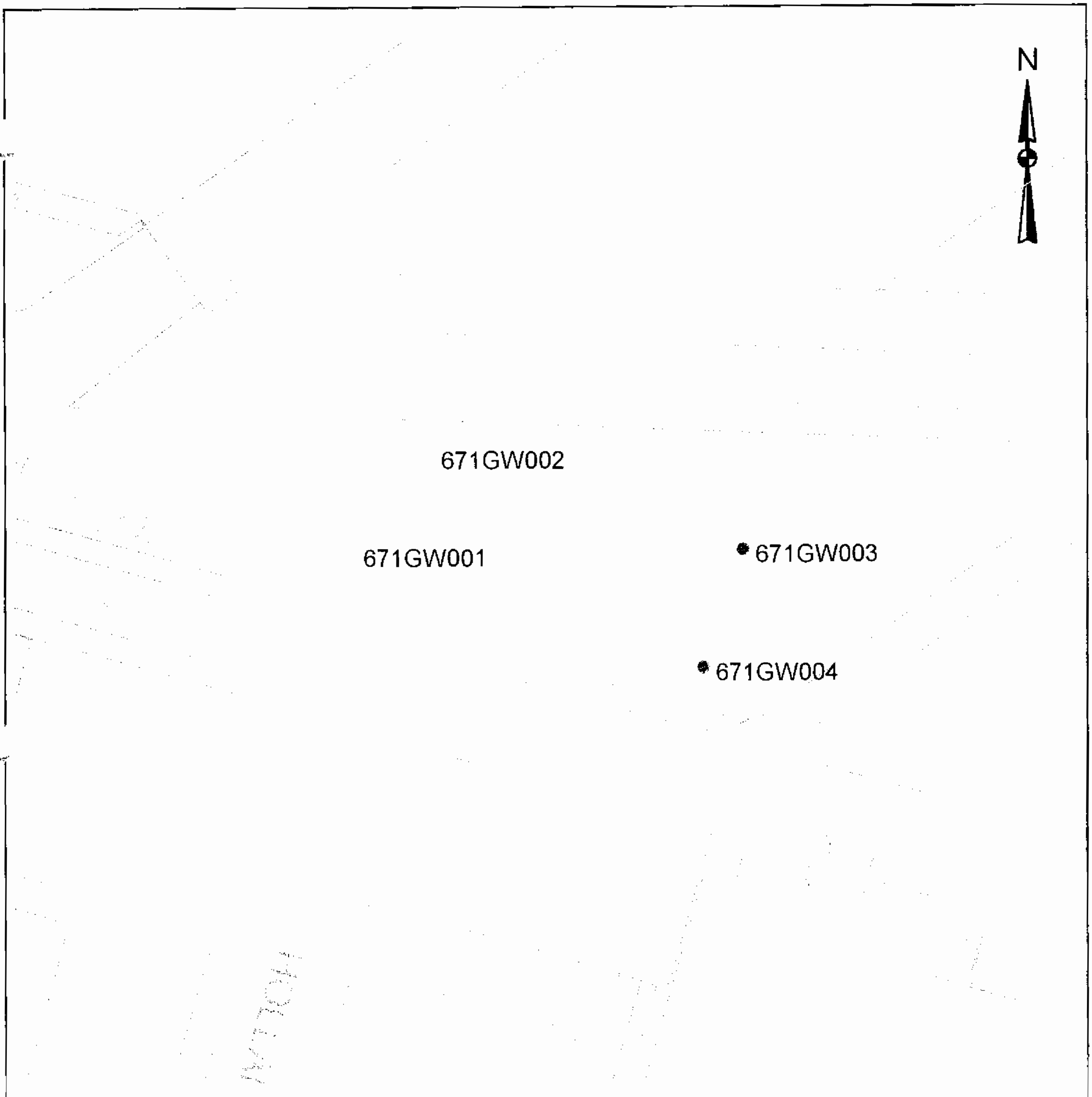
- NO COPCs
- < 1E-6
- 1E-6 to 5E-6
- 5E-6 to 1E-5
- 1E-5 to 1E-4
- > 1E-4

80 0 80 160 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.1.18
ZONE I
AOC 671

GROUNDWATER POINT RISK
INDUSTRIAL SCENARIO



LEGEND

- NO COPCs
- 0 to 0.1
- 0.1 to 0.5
- 0.5 to 1.0
- 1.0 to 3.0
- > 3.0

80 0 80 160 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.1.19
ZONE I
AOC 671

GROUNDWATER HAZARD INDEX
INDUSTRIAL SCENARIO

10.1.6.8 Remedial Goal Options

Soil

RGOs for carcinogens were based on the lifetime-weighted average for a site resident, as presented in Table 10.1.27 for surface soil. No hazard-based RGOs were necessary.

Groundwater

Groundwater RGOs based on the site resident and site worker scenarios are shown in Table 10.1.28 and Table 10.1.29 respectively.

10.1.7 Corrective Measures Considerations

Based on the analytical results and the human health risk assessment for AOC 671, COCs requiring further evaluation through the CMS process have been identified for surface soil and groundwater. The site is currently in a moderately developed urban setting and risk to human health was evaluated under both the residential and industrial (site worker) scenarios. For these scenarios, the incidental ingestion and dermal contact exposure pathways were evaluated. Hazard was evaluated for noncarcinogenic contaminants through incidental ingestion and dermal contact scenarios as well.

As recommended by SCDHEC, a COC is considered to be any chemical contributing to a cumulative risk level of 1E-06 or greater and/or a cumulative hazard index above 1.0, if its individual risk exceeds 1E-06 or its hazard quotient exceeds 0.1.

BEQ and n-nitroso-di-n-propylamine were identified as soil pathway COCs for AOC 671, while arsenic, manganese, mercury, and thallium were identified as the groundwater COCs. Table 10.1.30 presents cumulative and COC-specific exposure risks and hazard quotients.

Risk-based remedial goals for surface soil and groundwater are presented in Tables 10.1.27, 10.1.28, and 10.1.29. Potential corrective measures for soil are presented in Table 10.7.31.

Table 10.1.27
Residential-Based Remedial Goal Options Surface Soil
AOC 671
Charleston Naval Complex
Charleston, South Carolina

Chemical	Slope Factor (mg/kg-day)$^{-1}$	Reference Dose (mg/kg-day)	EPC mg/kg	Hazard-Based Remedial Goal Options 3 mg/kg	1 mg/kg	0.1 mg/kg	Risk-Based Remedial Goal Options 1E-06 mg/kg	1E-05 mg/kg	1E-04 mg/kg	Background Concentration mg/kg
Benzo(a)pyrene Equivalents	7.3	NA	1.1	ND	ND	ND	0.30	3.0	30	NA

Notes:
EPC exposure point concentration
NA not applicable
ND not determined
- Remedial goal options were based on the residential lifetime-weighted average for carcinogens.
and the child resident for noncarcinogens
mg/kg Milligrams per kilograms
mg/kg-day Milligrams per kilograms per day

Table 10.1.28
Residential-Based Remedial Goal Options Shallow Groundwater
AOC 671
Charleston Naval Complex
Charleston, South Carolina

Chemical	Oral SF $(mg/kg\text{-}day)^{-1}$	Oral RfD (mg/kg-day)	EPC mg/L	Hazard-Based Remedial Goal Options **0.1** mg/L	**1.0** mg/L	**3** mg/L	Risk-Based Remedial Goal Options **1E-06** mg/L	**1E-05** mg/L	**1E-04** mg/L	MCL mg/L	Background Concentration mg/L
Arsenic	1.5	0.0003	0.036	0.00047	0.0047	0.014	0.000044	0.00044	0.0044	0.05	0.023
Thallium	NA	7E-05	0.0035	0.00011	0.0011	0.0033	NA	NA	NA	0.002	0.002
Mercury	NA	0.0003	0.0096	0.00047	0.0047	0.0141	NA	NA	NA	0.002	NA
Manganese	NA	0.023	0.8035	0.03598	0.3598	1.0794	NA	NA	NA	NA	5.43

Notes:
EPC exposure point concentration
NA not applicable
- Remedial goal options were based on the residential lifetime-weighted average for carcinogens and the child resident for noncarcinogens.
mg/L milligrams per liters

Table 10.1.29
Worker-Based Remedial Goal Options Shallow Groundwater
AOC 671
Charleston Naval Complex
Charleston, South Carolina

Chemical	Oral SF (mg/kg-day)$^{-1}$	Oral RfD (mg/kg-day)	EPC mg/L	Hazard-Based Remedial Goal Options **0.1** mg/L	**1.0** mg/L	**3** mg/L	Risk-Based Remedial Goal Options **1E-06** mg/L	**1E-05** mg/L	**1E-04** mg/L	MCL mg/L	Background Concentration mg/L
Arsenic	1.5	0.0003	0.036	0.0031	0.031	0.092	0.00019	0.0019	0.019	0.05	0.023
Thallium	NA	7E-05	0.0035	0.00072	0.0072	0.021	NA	NA	NA	0.002	0.002
Mercury	NA	0.0003	0.0096	0.00307	0.0307	0.092	NA	NA	NA	0.002	NA
Manganese	NA	0.023	0.8035	0.23506	2.3506	7.052	NA	NA	NA	NA	5.43

Notes:
EPC exposure point concentration
NA not applicable
SF slope factor
RfD reference dose
mg/L milligrams per liter
mg/kg-day milligrams per liter per day

Table 10.1.30
AOC 671
Cumulative and Chemical-Specific Exposure Risks and Hazard

Chemical	Risk Industrial	Risk Residential	Hazard Industrial	Hazard Residential
Soil				
BEQs	7.4E-7	3.6E-6	ND	ND
N-nitroso-di-n-propylamine	2.2E-7	1.1E-7	ND	ND
Cumulative	9.6E-7	4.7E-7	ND	ND
Groundwater				
Arsenic	1.9E-4	8.2E-4	1.2	7.7
Manganese	ND	ND	0.48	3.2
Mercury	ND	ND	0.31	2.0
Thallium	ND	ND	0.34	2.2
Cumulative	1.9E-4	8.2E-4	2.33	15.1

Note:
ND = Not detected

Table 10.1.31
AOC 671
Potential Corrective Measures

Medium	Compounds	Potential Corrective Measures
Soil	BEQs, N-ntiroso-di-n-propylamine	a) No action b) Excavate, offsite disposal, and monitoring c) Containment/capping
Groundwater	Arsenic, Manganese, Mercury, Thallium	a) No action b) Monitoring c) Ex-situ physical/chemical treatment and discharge to POTW d) Ex-situ physical/chemical treatment and discharge through NPDES permitting

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10.2 AOC 672, Substation (Building 126) and AOC 673, Paint and Oil Storehouse (Building 169)

AOC 672 is the electrical substation in Building 126. This high-voltage substation was constructed in 1947 and modified in 1950. The structure is a single-story concrete-block building with a concrete floor and roof. A fenced area at the building's northwest corner enclosed several transformers which were mounted on a concrete pad, but have since been removed. The building area contains several high-voltage switches and breakers. Present equipment is non PCB, but historic equipment may have contained PCB dielectric fluid or PCB contaminated fluids.

AOC 673 is Building 169, a single-story, concrete-block structure constructed in 1949. Building 169 was once used to store paints, oils, and solvents associated with painting operations. In later years it was used to store fire-fighting equipment.

The combined AOC 672/673 area is located in a paved parking area between Piers P and Q.

Materials of concern, identified in the final RFI work plan, include dielectric fluids, paints, oils, solvents, VOCs, and hydrocarbons. Potential receptors include site workers who perform invasive activities which might bring them in direct contact with subsurface contaminants. The ecology of the Cooper River is also a potential receptor.

To fulfill CSI objectives and confirm the presence of contamination resulting from onsite activities, soil and groundwater were sampled in accordance with the final RFI work plan, as described in Section 3 of this report.

10.2.1 Soil Sampling and Analysis

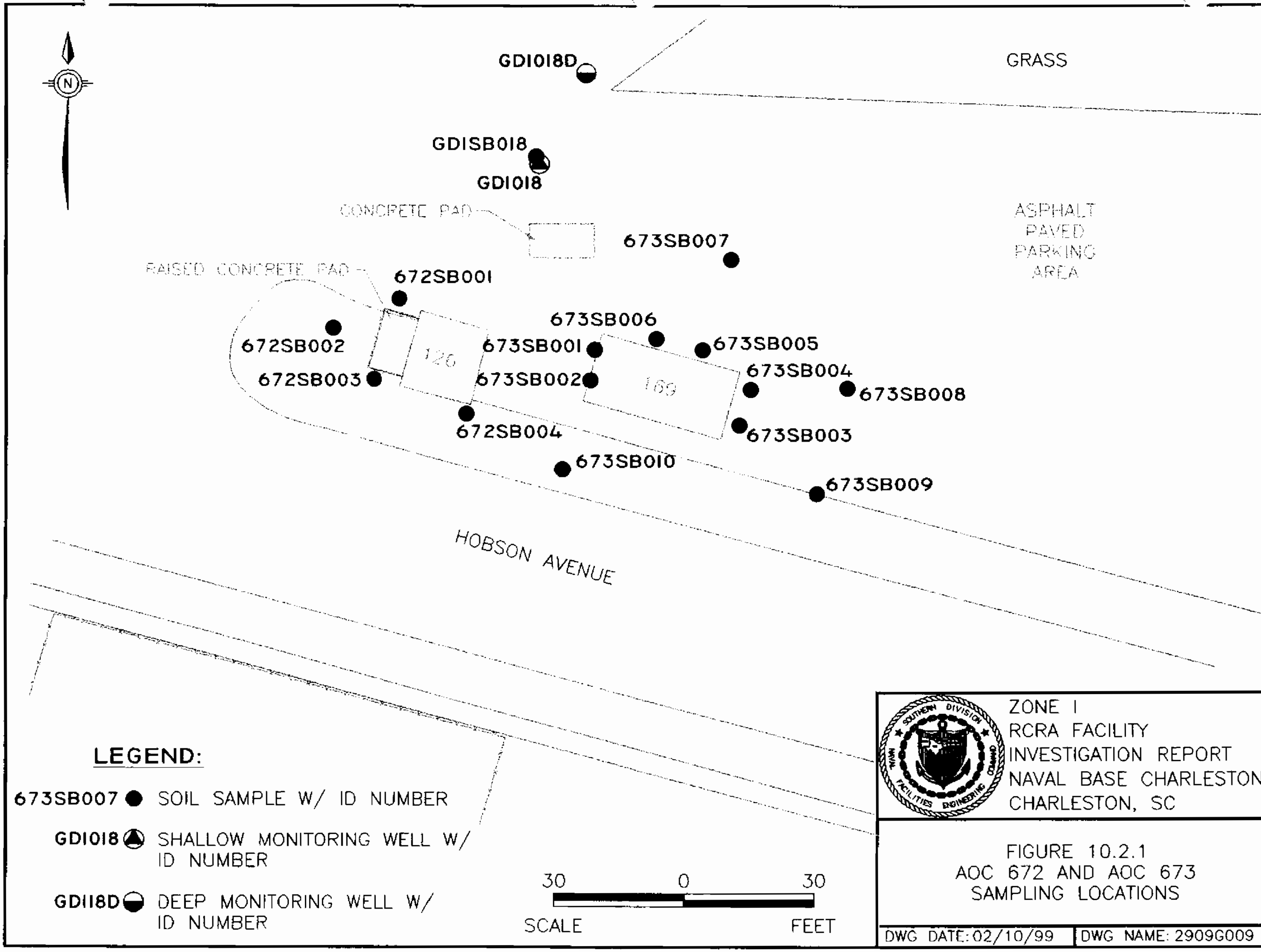
Soil was sampled in two rounds at the AOCs from the locations shown on Figure 10.2.1. The final RFI work plan proposed 10 soil samples from the upper-interval and 10 from the lower-interval. All 10 first-round upper-interval samples were collected. Six of the proposed first-round lower-interval samples were collected. Four lower-interval samples were not collected because the water table was encountered at less than 5 feet bgs. All samples were submitted for analysis of the standard suite of parameters, which includes VOCs, SVOCs, pesticides, PCBs, metals, and cyanide at DQO Level III. Two first-round upper-interval duplicate samples were submitted for Appendix IX analysis at DQO Level IV. One upper-interval sample was also analyzed for the physical parameters CEC, chloride, sulfur, ammonia, nitrate/nitrite, phosphorus, TOC, and total moisture.

Second-round sampling was performed at AOC 673 to further delineate arsenic contamination discovered during the first sampling round. No second-round samples were collected at AOC 672. Four second-round soil borings (673SB007 through 673SB010) were advanced at AOC 673. Upper- and lower-interval samples were collected from each boring and analyzed for arsenic only. One second-round upper-interval duplicate sample, collected at boring 673SB010, was also analyzed for arsenic only. Table 10.2.1 summarizes the soil samples collected at AOCs 672/673.

A grid-based soil boring (GDISB018) was advanced north of AOCs 672/673. Upper- and lower-interval samples from this boring were analyzed for the standard suite of parameters. Results of these analyses are discussed below and presented in Appendix D.

10.2.2 Nature and Extent of Contamination in Soil

Organic compound analytical data for soil are summarized in Table 10.2.2. Inorganic compound analytical data for soil are summarized in Table 10.2.3. Table 10.2.4 summarizes all analytes detected in soil at AOCs 672/673. Appendix D contains the complete analytical data report for all samples collected in Zone I.



ZONE I
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.2.1
AOC 672 AND AOC 673
SAMPLING LOCATIONS

DWG DATE: 02/10/99 | DWG NAME: 2909G009

Table 10.2.1
AOCs 672/673
Soil Sampling Summary

Sampling Round	Sampling Date	Samples Collected	Sample Analyses	Comments
1	02/20/95 02/21/95	Upper - 10 (10)	Standard Suite, Physical Parameters	Four lower samples were not collected due to a water table at less than 5 feet bgs.
		Lower - 6 (10)	Standard Suite	
		Duplicates - 2	Appendix IX	
2	04/07/98	Upper - 4	Arsenic	Borings 673SB007 through 673SB010 were added to delineate arsenic contamination identified during the first sampling round.
		Lower - 4	Arsenic	
		Duplicate - 1	Arsenic	

Notes:
( ) = Parentheses indicate number of samples proposed in the RFI work plan.
Standard Suite = VOCs, SVOCs, metals, cyanide, pesticides, and PCBs at DQO Level III.
Appendix IX = Standard suite, plus hex-Chrome, dioxins, herbicides, and OP pesticides.
Physical parameters analysis included CEC, chloride, sulfur, ammonia, nitrate/nitrite, phosphorus, TOC, and total moisture.

Table 10.2.2
AOCs 672/673
Organic Compound Analytical Results for Soil (μg/kg)

Parameter	Sample Interval	Detection Frequency	Detection Range	Mean	RBC (upper) SSL (lower)	Number of Samples Exceeding RBC or SSL
Volatile Organic Compounds						
Acetone	Upper	5/10	52.0 - 150	108	780,000	0
	Lower	3/6	27.0 - 65.0	40.0	8,000	0
Toluene	Upper	4/10	4.0 - 7.0	5.5	1,600,000	0
	Lower	1/6	3.0	3.0	6,000	0
Semivolatile Organic Compounds						
Di-n-butylphthalate	Upper	5/10	66.0 - 240	119	780,000	0
	Lower	3/6	71.0 - 150	104	2,300,000	0
Fluoranthene	Upper	1/10	88.0	88.0	310,000	0
	Lower	1/6	190	190	2,100,000	0
Phenanthrene	Upper	1/10	83.0	83.0	230,000	0
	Lower	0/6	ND	ND	660,000	0
Pyrene	Upper	2/10	53.0 - 61.0	57.0	230,000	0
	Lower	1/6	130	130	2,100,000	0
bis(2-Ethylhexyl)phthalate	Upper	2/10	59.0 - 240	150	46,000	0
	Lower	1/6	120	120	1,800,000	0
Pesticides and PCBs						
4,4'-DDD	Upper	5/10	6.3 - 28.0	12.7	2,700	0
	Lower	2/6	1.4 - 4.4	2.9	8,000	0
4,4'-DDE	Upper	10/10	8.2 - 240	80.2	1,900	0
	Lower	2/6	0.43 - 5.2	2.8	27,000	0
4,4'-DDT	Upper	7/10	4.2 - 220	59.0	1,900	0
	Lower	2/6	2.1 - 5.3	3.7	16,000	0
Chlordane	Upper	1/10	7.9	7.9	1,800	0
	Lower	0/6	ND	ND	5,000	0
Endosulfan sulfate	Upper	1/10	4.0	4.0	47,000	0
	Lower	0/6	ND	ND	4,600	0
Endrin	Upper	1/10	5.0	5.0	2,300	0
	Lower	0/6	ND	ND	500	0
Endrin aldehyde	Upper	1/10	2.4	2.4	2,300	0
	Lower	0/6	ND	ND	340	0
Heptachlor	Upper	1/10	1.4	1.4	140	0
	Lower	0/6	ND	ND	11,000	0

Table 10.2.2
AOCs 672/673
Organic Compound Analytical Results for Soil (μg/kg)

Parameter	Sample Interval	Detection Frequency	Detection Range	Mean	RBC (upper) SSL (lower)	Number of Samples Exceeding RBC or SSL
Heptachlor epoxide	Upper	1/10	20.0	20.0	70	0
	Lower	0/6	ND	ND	330	0
Methoxychlor	Upper	1/10	16.0	16.0	39,000	0
	Lower	2/6	2.4 - 5.3	3.9	80,000	0
alpha-BHC	Upper	1/10	1.2	1.2	100	0
	Lower	0/6	ND	ND	0.25	0
beta-BHC	Upper	1/10	3.2	3.2	350	0
	Lower	0/6	ND	ND	1.3	0
Herbicides						
2,4-D	Upper	1/2	19.0	19.0	78,000	0
	Lower	0/0	ND	ND	370	0
Dioxins						
2,3,7,8-TCDD equivalent (TEQs)	Upper	2/2	6.51E-6 - 1.42E-05	1.04E-05	4.3E-03	0
	Lower	0/0	ND	ND	1.6	0
OCDD	Upper	2/2	5.78E-03 - 6.51E-03	6.15E-03	4.3	0
	Lower	0/0	ND	ND	1,080	0
1234678-HpCDD	Upper	1/2	8.43E-04	8.43E-04	0.43	0
	Lower	0/0	ND	ND	108	0

Notes:
ND = Not Detected
μg/kg = micrograms per kilogram
See Table 5.5 for organic compound screening concentrations and their sources.

Table 10.2.3
AOCs 672/673
Inorganic Compound Analytical Results for Soil (mg/kg)

Parameter	Sample Interval	Detection Frequency	Detection Range	Mean	Background Concentration	RBC (upper) SSL (lower)	Number of Samples Exceeding: RBC & Background (upper) or SSL & Background (lower)
Aluminum (Al)	Upper	10/10	5,510 - 17,900	9,111	274,000	7,800	0
	Lower	6/6	2,180 - 11,800	8030	189,000	560,000	0
Arsenic (As)	Upper	14/14	3.0 - 42.9	17.0	21.6	0.43	5
	Lower	7/10	0.84 - 15.5	6.8	6.45	15	1
Barium (Ba)	Upper	10/10	13.3 - 34.6	19.9	54.2	550	0
	Lower	6/6	5.5 - 19.0	13.9	36.0	820	0
Beryllium (Be)	Upper	2/10	0.31 - 0.44	0.38	0.95	16	0
	Lower	0/6	ND	ND	0.67	32	0
Cadmium (Cd)	Upper	1/10	1.1	1.1	0.61	7.8	0
	Lower	0/6	ND	ND	0.54	4	0
Calcium (Ca)	Upper	10/10	15,100 - 85,300	43,500	NL	NL	0
	Lower	6/6	4,170 - 67,900	32,000	NL	NL	0
Chromium (Cr) (total)	Upper	10/10	19.2 - 44.1	27.6	34.5	39	1
	Lower	6/6	6.8 - 34.2	24.0	51.3	19	0
Cobalt (Co)	Upper	4/10	1.7 - 2.4	2.0	5.8	470	0
	Lower	3/6	1.6 - 2.7	2.2	3.48	990	0
Copper (Cu)	Upper	10/10	6.0 - 30.9	14.8	240	310	0
	Lower	6/6	1.1 - 18.2	8.6	11.5	5,600	0
Iron (Fe)	Upper	10/10	4,990 - 7,860	6,170	NL	NL	0
	Lower	6/6	2,470 - 14,600	7,630	NL	NL	0
Lead (Pb)	Upper	10/10	11.1 - 225	45.9	203	400	0
	Lower	6/6	2.9 - 11.3	7.8	12.3	400	0
Magnesium (Mg)	Upper	10/10	1,210 - 4,200	2,440	NL	NL	0
	Lower	6/6	352 - 4,000	2,250	NL	NL	0
Manganese (Mn)	Upper	10/10	37.6 - 100	58.1	419	160	0
	Lower	6/6	21.1 - 77.4	54.2	118	480	0

Table 10.2.3
AOCs 672/673
Inorganic Compound Analytical Results for Soil (mg/kg)

Parameter	Sample Interval	Detection Frequency	Detection Range	Mean	Background Concentration	RBC (upper) SSL (lower)	Number of Samples Exceeding: RBC & Background (upper) or SSL & Background (lower)
Mercury (Hg)	Upper	3/10	0.16 - 0.34	0.23	0.47	2.3	0
	Lower	0/6	ND	ND	ND	1.0	0
Nickel (Ni)	Upper	10/10	6.0 - 12.3	8.7	23.9	160	0
	Lower	5/6	6.1 - 13.0	9.3	15.7	65	0
Potassium (K)	Upper	6/10	1,040 - 1,380	1,190	NL	NL	0
	Lower	5/6	1,200 - 1,580	1,350	NL	NL	0
Selenium (Se)	Upper	9/10	0.60 - 1.1	0.83	1.49	39	0
	Lower	5/6	0.72 - 1.1	0.92	1.77	2.6	0
Silver (Ag)	Upper	0/10	ND	ND	NA	39	0
	Lower	1/6	0.73	0.73	ND	17	0
Sodium (Na)	Upper	2/10	414 - 860	637	NL	NL	0
	Lower	2/6	288 - 1,060	674	NL	NL	0
Tin (Sn)	Upper	9/10	1.1 - 2.9	1.9	7.5	4,700	0
	Lower	4/6	1.2 - 1.8	1.5	ND	5,500	0
Vanadium (V)	Upper	10/10	14.1 - 34.4	20.0	113	55	0
	Lower	6/6	5.4 - 28.5	18.5	38.1	3,000	0
Zinc (Zn)	Upper	10/10	40.8 - 321	103	206	2,300	0
	Lower	6/6	6.1 - 102	36.0	36.2	6,200	0

Notes:
NA = Not applicable
ND = Not detected
NL = Not listed
mg/kg = milligrams per kilogram
See Table 5.6 for inorganic element screening concentrations and their sources.

Table 10.2.4
AOC 672/673
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Volatile Organic Compounds (μg/kg)							
Acetone	672SB001	ND	780000	NA	27	8000	NA
	672SB003	100			28		
	673SB002	140			NT		
	673SB004	52			65		
	673SB005	150			NT		
	673SB006	99.5			NT		
Toluene	673SB003	7	1600000	NA	ND	6000	NA
	673SB004	4			3		
	673SB005	5			NT		
	673SB006	6			NT		
Semivolatile Organic Compounds (μg/kg)							
Di-n-butylphthalate	672SB001	91	780000	NA	91	2300000	NA
	672SB002	86			71		
	672SB003	110			ND		
	672SB004	240			150		
	673SB002	66			NT		

Table 10.2.4
AOC 672/673
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
bis(2-Ethylhexyl)phthalate	672SB001	240	46000	NA	ND	1800000	NA
(BEHP)	673SB004	59			120		
Fluoranthene	673SB002	88	310000	NA	NT	2100000	NA
	673SB004	ND			190		
Phenanthrene	673SB002	83	230000	NA	NT	660000	NA
Pyrene	672SB003	61	230000	NA	ND	2100000	NA
	673SB002	53			NT		
	673SB004	ND			130		
Pesticides/PCBs (mg/kg)							
alpha-BHC (alpha-HCH)	673SB005	1.2	100	NA	NT	0.25	NA
beta-BHC (beta-HCH)	673SB006	3.2	350	NA	NT	1.3	NA
Chlordane	673SB005	7.9	1800	NA	NT	5000	NA
4,4'-DDD	672SB002	6.3	2700	NA	ND	8000	NA
	672SB004	ND			1.4		
	673SB001	8.8			NT		
	673SB003	6.3			ND		
	673SB004	28			4.4		
	673SB005	14			NT		

Table 10.2.4
AOC 672/673
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
4,4'-DDE	672SB001	51	1900	NA	ND	27000	NA
	672SB002	240			ND		
	672SB003	88			ND		
	672SB004	21			0.43		
	673SB001	210			NT		
	673SB002	83			NT		
	673SB003	23.5			5.2		
	673SB004	59			ND		
	673SB005	18			NT		
	673SB006	8.2			NT		
4,4'-DDT	672SB001	23	1900	NA	5.3	16000	NA
	672SB002	63			ND		
	672SB003	37			ND		
	672SB004	11			2.1		
	673SB001	220			NT		
	673SB002	55			NT		
	673SB004	4.2			ND		
Endosulfan sulfate	672SB003	4	47000	NA	ND	4600	NA

Table 10.2.4
AOC 672/673
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Endrin	673SB004	5	2300	NA	ND	500	NA
Endrin aldehyde	673SB001	2.4	2300	NA	NT	340	NA
Heptachlor	673SB005	1.4	140	NA	NT	11000	NA
Heptachlor epoxide	672SB002	20	70	NA	ND	330	NA
Methoxychlor	672SB001	ND	39000	NA	5.3	80000	NA
	672SB003	16			ND		
	672SB004	ND			2.4		
Herbicides (mg/kg)							
2,4-D	673SB006	19	78000	NA	NT	370ᵃ	NA
Dioxin Compounds (ng/kg)							
2,3,7,8-TCDD equivalents (TEQs)	673SB003	0.00651	4.3	NA	NT	1600	NA
	673SB006	0.01421			NT		
1234678-HpCDD	673SB006	0.843	430	NA	NT	108000	NA
OCDD	673SB003	6.51	4300	NA	ND	1080000	NA
	673SB006	5.783			NT		
Inorganics (mg/kg)							
Aluminum (Al)	672SB001	8560	7800	27400	7970	560000	18900
	672SB002	10300			2180		
	672SB003	11800			10200		

Table 10.2.4
AOC 672/673
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Aluminum (Al) (Continued)	672SB004	17900			11800		
	673SB001	7900			NT		
	673SB002	6750			NT		
	673SB003	8380			7680		
	673SB004	6730			8370		
	673SB005	5510			NT		
	673SB006	7280			NT		
Arsenic (As)	672SB001	4.7	0.43	21.6	ND	15	6.45
	672SB002	13.3			0.84		
	672SB003	6.5			4.7		
	672SB004	8.9			9.9		
	673SB001	27			NT		
	673SB002	42.9			NT		
	673SB003	34			ND		
	673SB004	31.4			7.5		
	673SB005	27.7			NT		
	673SB006	3.7			NT		
	673SB007	8.2			2.8		

Table 10.2.4
AOC 672/673
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Arsenic (As) (Continued)	673SB008	12.5			6.6		
	673SB009	14.8			ND		
	673SB010	2.95			15.5		
Barium (Ba)	672SB001	16.6	550	54.2	13.3	820	36
	672SB002	20.2			5.5		
	672SB003	23.7			18		
	672SB004	34.6			19		
	673SB001	23			NT		
	673SB002	20.1			NT		
	673SB003	15.95			13.5		
	673SB004	14.9			14.2		
	673SB005	13.3			NT		
	673SB006	17			NT		
Beryllium (Be)	672SB002	0.31	16	0.95	ND	32	0.67
	673SB006	0.44			NT		
Cadmium (Cd)	672SB004	1.1	7.8	0.61	ND	4	0.54

Table 10.2.4
AOC 672/673
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Chromium (Cr) (total)	672SB001	44.1	39	34.5	25.4	19	51.3
	672SB002	25.2			6.8		
	672SB003	29.2			34.2		
	672SB004	34.3			25.5		
	673SB001	28.1			NT		
	673SB002	21.8			NT		
	673SB003	27.3			28.5		
	673SB004	24.7			23.8		
	673SB005	19.2			NT		
	673SB006	22.55			NT		
Chromium (Cr6) (hexavalent)	673SB003	0.01	39	ND	NT	19	ND
	673SB006	0.01			NT		
Cobalt (Co)	672SB004	ND	470	5.8	2.7	990	3.48
	673SB001	2.3			NT		
	673SB003	1.75			1.6		
	673SB004	ND			2.4		
	673SB005	1.7			NT		
	673SB006	2.35			NT		

Table 10.2.4
AOC 672/673
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Copper (Cu)	672SB001	11.3	310	240	12.3	5600	11.5
	672SB002	12			1.1		
	672SB003	9.9			18.2		
	672SB004	20.6			5.4		
	673SB001	24.1			NT		
	673SB002	30.9			NT		
	673SB003	11.2			9.2		
	673SB004	14.8			5.6		
	673SB005	6.0			NT		
	673SB006	6.75			NT		
Lead (Pb)	672SB001	18.4	400	203	7.3	400	12.3
	672SB002	36.9			2.9		
	672SB003	25.7			9.3		
	672SB004	225			10.4		
	673SB001	49.7			NT		
	673SB002	33.2			NT		
	673SB003	11.1			5.8		

Table 10.2.4
AOC 672/673
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Lead (Pb) (Continued)	673SB004	17.2			11.3		
	673SB005	29.6			NT		
	673SB006	11.95			NT		
Manganese (Mn)	672SB001	100	160	419	48.5	480	118
	672SB002	45.9			21.1		
	672SB003	77.9			67.8		
	672SB004	42.7			67		
	673SB001	44.5			NT		
	673SB002	56.9			NT		
	673SB003	62.05			43.4		
	673SB004	45.9			77.4		
	673SB005	37.6			NT		
	673SB006	67.55			NT		
Mercury (Hg)	672SB004	0.18	2.3	0.47	ND	1.0	ND
	673SB001	0.34			NT		
	673SB002	0.16			NT		

Table 10.2.4
AOC 672/673
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Nickel (Ni)	672SB001	12.3	160	23.9	9.4	65	15.7
	672SB002	8.3			ND		
	672SB003	10.1			13		
	672SB004	9.4			8.1		
	673SB001	7.6			NT		
	673SB002	7.9			NT		
	673SB003	9.55			10		
	673SB004	8.3			6.1		
	673SB005	6.0			NT		
	673SB006	7.7			NT		
Selenium (Se)	672SB001	1.1	39	1.49	1.0	2.6	1.77
	672SB002	1.0			0.72		
	672SB003	ND			1.1		
	672SB004	0.86			1.0		
	673SB001	0.79			NT		
	673SB002	0.77			NT		
	673SB003	0.595			0.77		

Table 10.2.4
AOC 672/673
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Selenium (Se) (Continued)	673SB004	0.75			ND		
	673SB005	0.94			NT		
	673SB006	0.63			NT		
Silver (Ag)	672SB002	ND	39	NA	0.73	17	ND
Tin (Sn)	672SB001	1.6	4700	7.5	1.2	5500	ND
	672SB003	2.8			1.6		
	672SB004	2.9			1.8		
	673SB001	2.0			NT		
	673SB002	2.1			NT		
	673SB003	1.3			1.4		
	673SB004	2.3			ND		
	673SB005	1.1			NT		
	673SB006	1.1			NT		
Vanadium (V)	672SB001	21	55	113	17.1	3000	38.1
	672SB002	20.4			5.4		
	672SB003	21.3			22.1		
	672SB004	34.4			28.5		

Table 10.2.4
AOC 672/673
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Vanadium (V) (Continued)	673SB001	20.5			NT		
	673SB002	17.1			NT		
	673SB003	19			18.4		
	673SB004	16.3			19.6		
	673SB005	14.1			NT		
	673SB006	15.7			NT		
Zinc (Zn)	672SB001	321	2300	206	22	6200	36.2
	672SB002	65.6			6.1		
	672SB003	105			32.9		
	672SB004	76.9			24.2		
	673SB001	148			NT		
	673SB002	119			NT		
	673SB003	40.75			28.8		
	673SB004	44.1			102		
	673SB005	47.4			NT		
	673SB006	59.55			NT		

Notes:

a	=	Background value for non clay samples
*	=	Residential RBCs (THQ=0.1) were used as a reference concentration for upper-interval samples. Generic soil-to groundwater SSLs (DAF=10) from *Soil Screening Guidance: Technical Background Document* (USEPA, 1996b) were used as a reference concentration for lower-interval samples.

Bold concentrations exceed the RBCs, SSL, and the zone background
All background values for Zone I are based on twice the means of the grid sample concentrations.

NA	=	Not applicable/not available
ND	=	Not detected
NT	=	Not taken
RBC	=	Risk-based concentration
SSL	=	Soil screening level
µg/kg	=	micrograms per kilogram
mg/kg	=	milligrams per kilogram

Volatile Organic Compounds in Soil

Two VOCs, acetone and toluene, were detected in surface and subsurface soil at AOCs 672/673. Concentrations of these analytes did not exceed the RBCs or SSLs.

The same two VOCs, were also detected in both surface (acetone = 58 μg/kg; toluene = 40 μg/kg) and subsurface soil (acetone = 42 μg/kg; toluene = 4 μg/kg) samples at grid soil boring GDISB018 at similar concentrations. Again, concentrations of these analytes were far below their respective RBCs or SSLs.

Semivolatile Organic Compounds in Soil

Five SVOCs, di-n-butylphthalate, fluoranthene, phenanthrene, pyrene, and bis(2-Ethylhexyl)phthalate were detected in surface soil at the AOCs 672/673. All concentrations of these analytes were far below their respective RBCs.

Di-n-butylphthalate, fluoranthene, pyrene, and bis(2-Ethylhexyl)phthalate were also detected in subsurface soil. All subsurface SVOC concentrations were far below their respective SSLs.

No SVOCs were detected in surface or subsurface soils at GDISB018.

Pesticides and PCBs in Soil

Twelve pesticides were detected in surface soil at AOCs 672/673. Four pesticides were detected in subsurface soil. No pesticide concentrations in surface or subsurface soils exceeded their RBCs or SSLs. No PCBs were detected in surface or subsurface soils at this site.

Five pesticides detected in surface soil were also detected in grid surface soil sample GDISB01801: 4,4'-DDT (6.7 μg/kg), 4,4'-DDD (37 μg/kg), 4,4'-DDE (74 μg/kg), endrin (8.0 μg/kg), and endrin aldehyde (2.7 μg/kg). These grid sample concentrations were similar to those found at AOCs 672/673, and were far below the RBCs. No pesticides were detected in subsurface soil sample GDISB01802. No PCBs were detected in surface or subsurface soils at GDISB018.

Other Organic Compounds in Soil

The herbicide 2,4-D was detected in the surface soil duplicate sample 673SB00601, at a concentration far below its RBC.

Dioxins were detected in both duplicate samples (673SB00301 and 673SB00601) collected at AOCs 672/673. In accordance with recent dioxin guidance (USEPA *Interim Supplemental Guidance to RAGS: Region IV Collection, Human Health Risk Assessment*, Bulletin No. 2 [USEPA, 1995c]) and Section 7 of this report, the TEQs were calculated as 6.51E-06 and 1.4E-05 μg/kg for samples 673SB00301 and 673SB00601, respectively. These TEQs are far below the RBC of 4.3E-03 μg/kg for 2,3,7,8-TCDD in soil.

Inorganics in Soil

Twenty-one metals were detected in surface soil at AOCs 672/673. Five of 14 first-round surface soil arsenic concentrations (673SB00101 through 673SB00501) exceeded both the RBC and surface soil background concentration for this analyte. The range of arsenic exceedances was 27 to 42.9 mg/kg. Chromium (total) exceeded its RBC and surface soil background concentration in sample 672SB00101, at 44.1 mg/kg.

Nineteen metals were detected in subsurface soil. Arsenic exceeded its SSL and subsurface soil background concentration in sample 673SB01002, at 15.5 mg/kg.

Twenty-three metals were detected in surface soil at grid soil boring GDISB018. Copper exceeded its RBC and surface soil background concentration, at 556 mg/kg. Thallium slightly exceeded its

RBC, at 0.66 mg/kg. Twenty metals were detected in subsurface soil at grid soil boring GDISB018. All subsurface metal concentrations at GDISB018 were far below their respective SSLs and subsurface background concentrations.

10.2.3 Groundwater Sampling and Analysis

In accordance with the final RFI work plan, no monitoring wells were installed to characterize groundwater at AOCs 672/673. A shallow and deep grid-based monitoring well pair were sampled to characterize the zone perimeter groundwater in the vicinity of the AOCs. Wells GDI018 and GDI18D are located directly north and downgradient of the site.

The shallow grid-based monitoring well was installed at 12.5 feet bgs in an upper sand layer of the Wando Formation. The deep grid-based well was installed at 44 feet bgs at the base of a lower sand layer in the Wando Formation. All wells were installed in accordance with Section 3.2.3 of this report.

Samples from the grid-based well pair GDI018 and GDI18D were analyzed for the standard suite of parameters, plus chloride, sulfate, and TDS. Both wells were sampled during four sampling rounds. Results of these analyses are discussed below relative to AOCs 672/673; detailed results are presented in Appendix D.

Shallow Groundwater Results

No VOCs were detected in shallow groundwater at grid well GDI018. SVOC analyses at GDI018 detected di-n-butylphthalate (1 μg/L) during the second sampling round and benzoic acid during the third (2 μg/L) and fourth (1 μg/L) sampling rounds. The concentrations for these analytes were far below their respective tap-water RBCs. Pesticide analyses from the first sampling round at GDI018 detected delta-BHC at a concentration (7.1 μg/L) exceeding its tap-water RBC. No pesticides were detected at GDI018 during subsequent sampling rounds.

In all, 16 metals were detected during the four sampling rounds of shallow groundwater at GDI018. Thallium (5.5 μg/L) exceeded its tap-water RBC, MCL, and shallow groundwater background concentration during the third sampling round. All other metal concentrations were far below their respective tap-water RBCs, MCLs, and shallow groundwater background concentrations.

Deep Groundwater Results

In deep groundwater, VOC analyses from the first sampling round at GDI18D detected chloroethane at a concentration (5.0 μg/L) slightly exceeding its tap-water RBC. No VOCs were detected during subsequent sampling rounds at GDI18D. SVOC analyses at GDI18D detected benzoic acid (1 μg/L) during the second sampling round and naphthalene (1 μg/L) during the third sampling round. The concentrations for these analytes were far below their respective tap-water RBCs. Pesticide analyses from the fourth sampling round at GDI18D detected delta-BHC at a concentration (0.40 μg/L) slightly exceeding its tap-water RBC.

In all, 15 metals plus cyanide were detected during the four sampling rounds at deep grid well GDI18D. During the second sampling round, mercury (1.9 μg/L) exceeded its tap-water RBC, but was below its MCL. No background concentration is available for mercury in deeper groundwater. During the second, third, and fourth sampling rounds, thallium exceeded its tap-water RBC, MCL, and deep groundwater background concentration. All other deep groundwater metal concentrations were far below their respective tap-water RBCs, MCLs, and deep groundwater background concentrations.

10.2.4 Fate and Transport Assessment

AOC 672 is the electrical substation in Building 126. A fenced compound at the northwest corner used to enclose several transformers. Both Building 126 and the transformer area contain several high-voltage switches and breakers. AOC 673 is Building 169, which was used to store paints, oils, and solvents associated with painting operations. It was also used to store fire-fighting equipment. The combined AOCs 672/673 area is located in a paved parking area near Pier Q.

Environmental media sampled as part of the AOCs 672/673 investigation included surface and subsurface soils. Potential constituent migration pathways investigated for AOCs 672/673 include soil-to-groundwater and emission of volatile compounds from surface soil-to-air.

10.2.4.1 Soil-to-Groundwater Cross-Media Transport

Tables 10.2.5 and 10.2.6 compare maximum detected organic and inorganic constituent concentrations, respectively, in surface and subsurface soil to leachability-based generic SSLs. The SSLs were modified from those presented in USEPA *Soil Screening Guidance: Technical Background Document*, (USEPA, 1996a), or were calculated independently assuming a dilution factor of 10. A DAF of 10 was chosen rather than the value of 20 used in RFI reports for some other CNC zones because the relatively low hydraulic conductivities and hydraulic gradients of Zone I result in less leachate dilution by groundwater. Where generic SSLs for organics were not listed in the *Technical Background Document*, they were calculated. Where calculated SSLs differed from the EPA's generic values, the EPA values were used.

Organic Compounds

Two organic constituents - alpha-BHC and beta-BHC - were detected in the AOC 673 surface soil at concentrations exceeding groundwater protection SSLs. Alpha-BHC was detected in only one of 10 surface samples (1.2 μg/kg at 673SB005), and was not detected in any of the six subsurface soil samples. Figure 10.2.2 presents alpha-BHC concentrations detected at AOCs 672/673. Beta-BHC was detected in only one of 10 surface soil samples (3.2 μg/kg at 673SB006), and was not detected in any of the six subsurface soil samples. Figure 10.2.3 presents beta-BHC concentrations detected at AOCs 672/673.

Table 10.2.5
Organic Chemicals Detected in Surface Soil and Subsurface Soil
Comparison to Cross-Media SSLs, Tap Water RBCs, and Saltwater Surface Water Chronic Screening Levels
AOC 672/673
Charleston Naval Complex
Charleston, South Carolina

Parameter	Maximum Concentration				Screening Concentration									
	Surface Soil	Subsurface Soil	Sediment	Shallow GW	Soil to GW SSL	Soil to Air SSL	Tap Water RBC	Saltwater Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Volatil-ization Potential	Ground-water Migration Concern	Surface Water Migration Concern
Volatile Organic Compounds														
Acetone	150	65	NA	NA	8000	1.0E+08	3700	NA	µG/KG	µG/L	NO	NO	NO	NO
Toluene	7	3	NA	NA	6000	650000	750	37	µG/KG	µG/L	NO	NO	NO	NO
Semivolatile Organic Compounds														
Di-n-butylphthalate	240	150	NA	NA	2300000	2300000	3700	3.4	µG/KG	µG/L	NO	NO	NO	NO
bis(2-Ethylhexyl)phthalate (BEHP) c	240	120	NA	NA	1800000	31000000	4.8	NA	µG/KG	µG/L	NO	NO	NO	NO
Fluoranthene	88	190	NA	NA	2100000	NA	1500	1.6	µG/KG	µG/L	NO	NO	NO	NO
Phenanthrene	83	ND	NA	NA	660000 a	NA	1100	NA	µG/KG	µG/L	NO	NO	NO	NO
Pyrene	61	130	NA	NA	2100000	NA	1100	NA	µG/KG	µG/L	NO	NO	NO	NO
Pesticides/PCBs														
alpha-BHC (alpha-HCH) c	1.2	ND	NA	NA	0.25	800	0.011	1400	µG/KG	µG/L	YES	NO	NO	NO
beta-BHC (beta-HCH) c	3.2	ND	NA	NA	1.3	1E+09	0.037	NA	µG/KG	µG/L	YES	NO	NO	NO
Chlordane c	7.9	ND	NA	NA	5000	20000	0.19	0.004	µG/KG	µG/L	NO	NO	NO	NO
4,4'-DDD c	28	4.4	NA	NA	8000	NA	0.28	0.025	µG/KG	µG/L	NO	NO	NO	NO
4,4'-DDE c	240	5.2	NA	NA	27000	NA	0.2	0.14	µG/KG	µG/L	NO	NO	NO	NO
4,4'-DDT c	220	5.3	NA	NA	16000	1E+09	0.2	0.001	µG/KG	µG/L	NO	NO	NO	NO
Endosulfan sulfate	4	ND	NA	NA	4600 a	NA	220	NA	µG/KG	µG/L	NO	NO	NO	NO
Endrin	5	ND	NA	NA	500	NA	11	0.0023	µG/KG	µG/L	NO	NO	NO	NO
Endrin aldehyde	2.4	ND	NA	NA	340 a	NA	11	NA	µG/KG	µG/L	NO	NO	NO	NO
Heptachlor c	1.4	ND	NA	NA	11000	100	0.0023	0.0036	µG/KG	µG/L	NO	NO	NO	NO
Heptachlor epoxide c	20	ND	NA	NA	330	5000	0.0012	0.0036	µG/KG	µG/L	NO	NO	NO	NO
Methoxychlor	16	5.3	NA	NA	80000	NA	180	0.03	µG/KG	µG/L	NO	NO	NO	NO
Herbicides														
2,4-D	19	NA	NA	NA	370 a	7000000	61	NA	µG/KG	µG/L	NO	NO	NO	NO
Dioxin Compounds														
2,3,7,8-TCDD equivalents (TEQs) c	0.0142	NA	NA	NA	1600 a	NA	0.45	10	NG/KG	PG/L	NO	NO	NO	NO
1234678-HpCDD c	0.843	NA	NA	NA	108000 a	NA	45	NA	NG/KG	PG/L	NO	NO	NO	NO
OCDD c	6.51	NA	NA	NA	1080000 a	NA	450	NA	NG/KG	PG/L	NO	NO	NO	NO

Notes:
Sources of screening concentrations appear in Table 5.5.
Explanations of fate and transport screening procedures appear in Section 6.2.
Frequency and range of detections, average detected concentrations, and number of screening concentration exceedances appear in Table 10.2.2.

a - Calculated soil to groundwater SSL value (See Table 6.2)
c - Carcinogenic
G'' Groundwater

NA - Not applicable/not available
ND - Not detected
RBC - Risk-based co ration
SSL - Soil screening

NG/KG - Nanograms per kilogram
µG/KG - Micrograms per kilogram
PG/L - Picograms per liter
µG/L - Micrograms per liter

Table 10.2.6
Inorganic Chemicals Detected in Surface Soil and Subsurface Soil
Comparison to Cross-Media SSLs, Tap Water RBCs, Saltwater Surface Water Chronic Screening Levels, and Background Values
AOCs 672/673
Charleston Naval Complex,
Charleston, South Carolina

Parameter	Maximum Concentration Surface Soil	Subsurface Soil	Sediment	Shallow GW	Screening Concentration Soil to GW SSL	Soil Background	Soil to Air SSL	Tap Water RBC	Shallow GW Background	Saltwater Surf. Wtr Chronic	Soil Units	Water Units	Leaching Potential	Fugitive Particulate Inhalation Concern	Ground-water Migration Concern	Surface Water Migration Concern
Inorganic Chemicals																
Aluminum (Al)	17900	11800	NA	NA	560000 a	27400	NA	37000	1440	NA	MG/KG	µG/L	NO	NO	NO	NO
Arsenic (As) c	42.9	15.5	NA	NA	15	21.6	750	0.045	23	36	MG/KG	µG/L	YES	NO	NO	NO
Barium (Ba)	34.6	19	NA	NA	820	54.2	690000	2600	110	NA	MG/KG	µG/L	NO	NO	NO	NO
Beryllium (Be)	0.44	ND	NA	NA	32	0.95	1300	73	1.1	NA	MG/KG	µG/L	NO	NO	NO	NO
Cadmium (Cd)	1.1	ND	NA	NA	4	0.61	1800	18	NA	9.3	MG/KG	µG/L	NO	NO	NO	NO
Chromium (Cr) (total)	44.1	34.2	NA	NA	19	51.3	270	180	14.3	50	MG/KG	µG/L	YES	NO	NO	NO
Cobalt (Co)	2.4	2.7	NA	NA	990 a	5.8	NA	2200	2.2	NA	MG/KG	µG/L	NO	NO	NO	NO
Copper (Cu)	30.9	18.2	NA	NA	5600 a	240	NA	1500	4.4	2.9	MG/KG	µG/L	NO	NO	NO	NO
Lead (Pb)	225	11.3	NA	NA	400	203	400	15	4.4	8.5	MG/KG	µG/L	NO	NO	NO	NO
Manganese (Mn)	100	77.4	NA	NA	480 a	419	NA	730	5430	NA	MG/KG	µG/L	NO	NO	NO	NO
Mercury (Hg)	0.34	ND	NA	NA	1	0.47	10	11	NA	0.025	MG/KG	µG/L	NO	NO	NO	NO
Nickel (Ni)	12.3	13	NA	NA	65	23.9	13000	730	13.3	8.3	MG/KG	µG/L	NO	NO	NO	NO
Selenium (Se)	1.1	1.1	NA	NA	2.6	1.77	NA	180	ND	71	MG/KG	µG/L	NO	NO	NO	NO
Silver (Ag)	ND	0.73	NA	NA	17	NA	NA	180	NA	0.23	MG/KG	µG/L	NO	NO	NO	NO
Tin (Sn)	2.9	1.8	NA	NA	5500 a	7.5	NA	22000	NA	NA	MG/KG	µG/L	NO	NO	NO	NO
Vanadium (V)	34.4	28.5	NA	NA	3000	113	NA	260	14	NA	MG/KG	µG/L	NO	NO	NO	NO
Zinc (Zn)	321	102	NA	NA	6200	206	NA	11000	24.4	86	MG/KG	µG/L	NO	NO	NO	NO

Notes:
Sources of screening concentrations appear in Table 5.6
Explanations of fate and transport screening procedures appear in Section 6.2.
Frequency and range of detections, average detected concentrations, and number of screening concentration exceedances appear in Table 10.2.3.

Background values for soil are shown for comparison purposes only.
Maximum groundwater concentrations are screened against the greater of tap water RBCs or corresponding background values to determine groundwater migration concern.

a - Calculated soil to groundwater SSL value (See Table 6.2)
c - Carcinogenic
GW - Groundwater

NA - Not available/Not applicable
ND - Not detected
RBC - Risk-based concentration

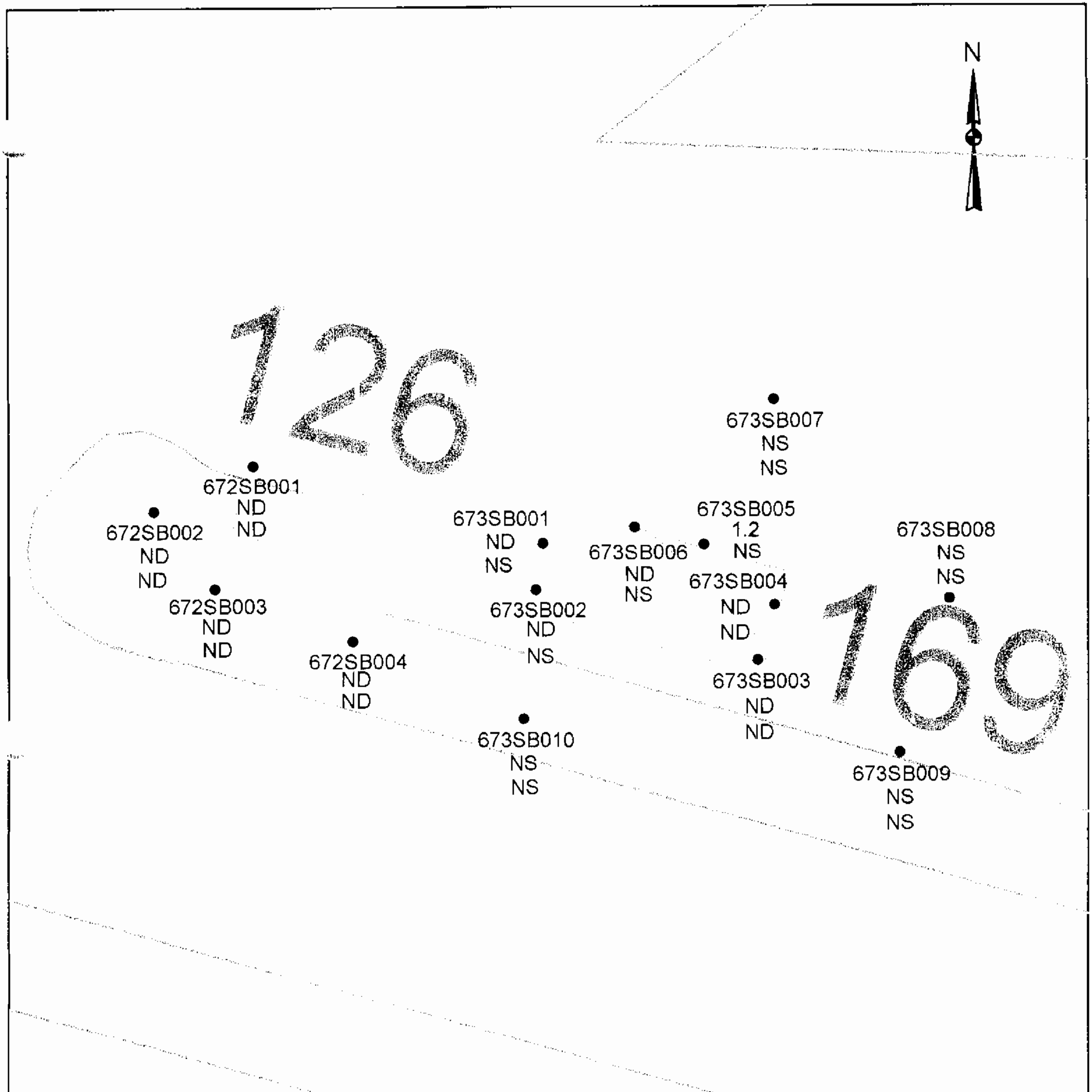
SSL - Soil screening level
MG/KG - Milligrams per kilogram
µG/L - Micrograms per liter

Since the presence of alpha-BHC and beta-BHC at AOC 673 is not consistent with historical activities at this site, the source of these constituents at this site is unclear. The vertical distribution of these two pesticides is consistent with a surface application at the site or fugitive dust from areas of nearby application. The limited detection in only one surface soil sample for both alpha-BHC and beta-BHC indicates a very limited residual mass in the surface soil. The absence of a detection in the subsurface soil and the limited detection in the surface soil indicate that any residual contamination is immobilized in the surface soil, and that the soil-to-groundwater migration pathway is invalid at AOCs 672/673 for alpha-BHC and beta-BHC.

Inorganic Compounds

Two inorganics – arsenic and chromium (total) – were detected at concentrations exceeding their respective SSLs in both surface soil and subsurface soil. Arsenic detections were widespread, but concentrations were above the SSL (15 mg/kg) in only five surface soil samples (673SB001 to 673SB005) and only slightly above in one subsurface soil sample (673SB010). Figure 10.2.4 presents arsenic concentrations detected at AOCs 672/673. Chromium detections were also widespread, and were above the SSL (19 mg/kg) in all 10 surface soil samples and in five of six subsurface soil samples. Figure 10.2.5 presents chromium concentrations detected at AOCs 672/673.

The presence of arsenic and chromium is not consistent with historical activities at AOCs 672/673, but both are common constituents of Zone I soils. Furthermore, the subsurface exceedance of arsenic and all of the exceedances of chromium (both surface and subsurface) were below the zone-specific background. Therefore, these concentrations are considered to be within the range of natural occurrence and are eliminated from further consideration in this transport evaluation. While these concentrations may be above a theoretical SSL, existing site conditions are not considered to be a potential threat to groundwater.



LEGEND

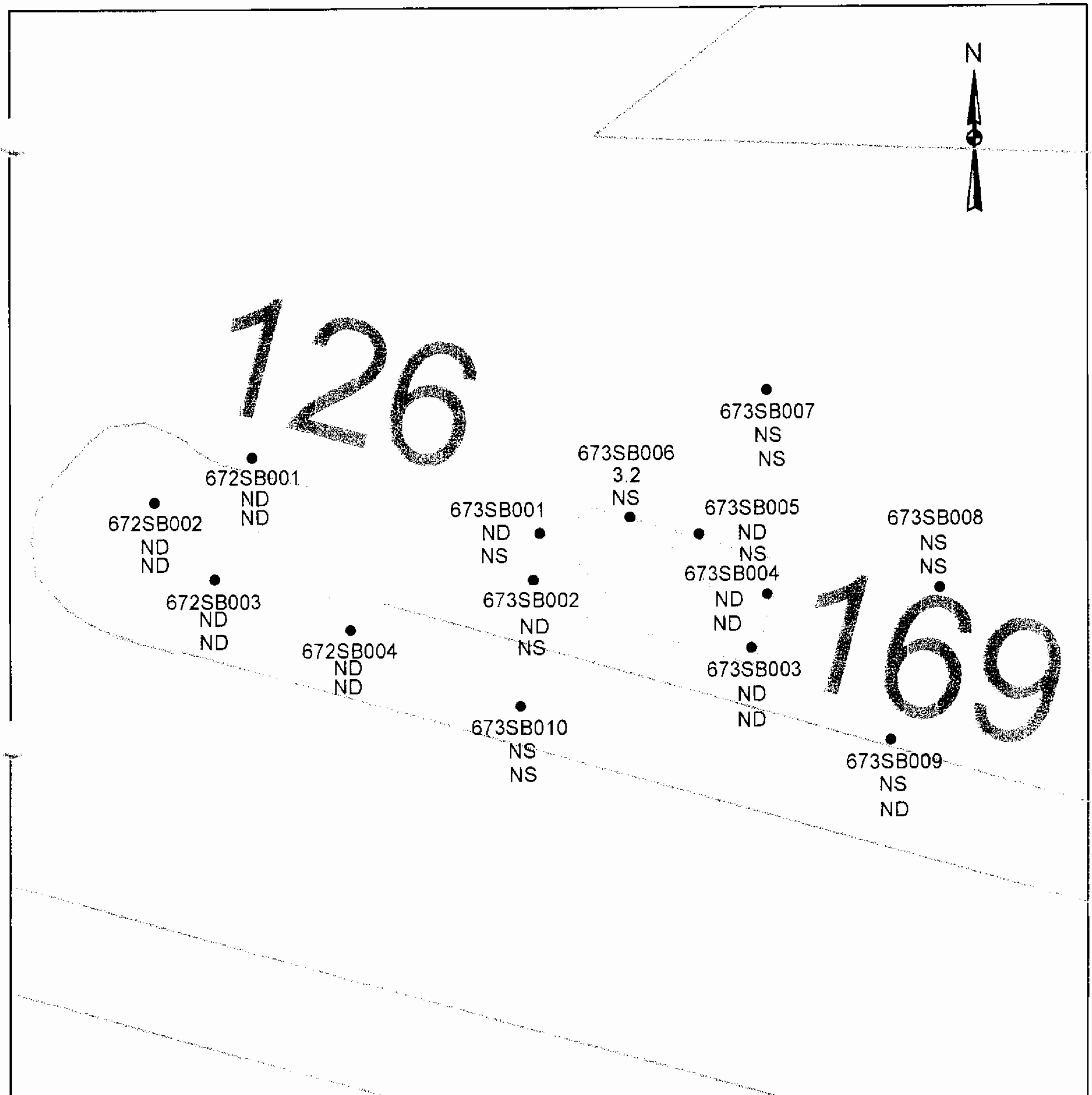
■ MONITORING WELL LOCATION
● ZONE I SOIL BORING LOCATION
12.30 ZONE I SURFACE SOIL CONC. (UG/KG)
12.30 ZONE I SUBSURFACE SOIL CONC. (UG/KG)
12.30 MAXIMUM QUARTERLY GW CONC. (UG/L)
NS NO SAMPLE TAKEN
ND NON DETECT

SCALE
10 0 10 20 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.2.2
ZONE I
AOC 672 & 673
ALPHA-BHC
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=NA RBC=100 UG/KG SSL=.25 UG/KG



LEGEND

- ■ MONITORING WELL LOCATION
- ● ZONE I SOIL BORING LOCATION
- 12.30 ZONE I SURFACE SOIL CONC. (UG/KG)
- 12.30 ZONE I SUBSURFACE SOIL CONC. (UG/KG)
- *12.30* MAXIMUM QUARTERLY GW CONC. (UG/L)
- NS NO SAMPLE TAKEN
- ND NON DETECT

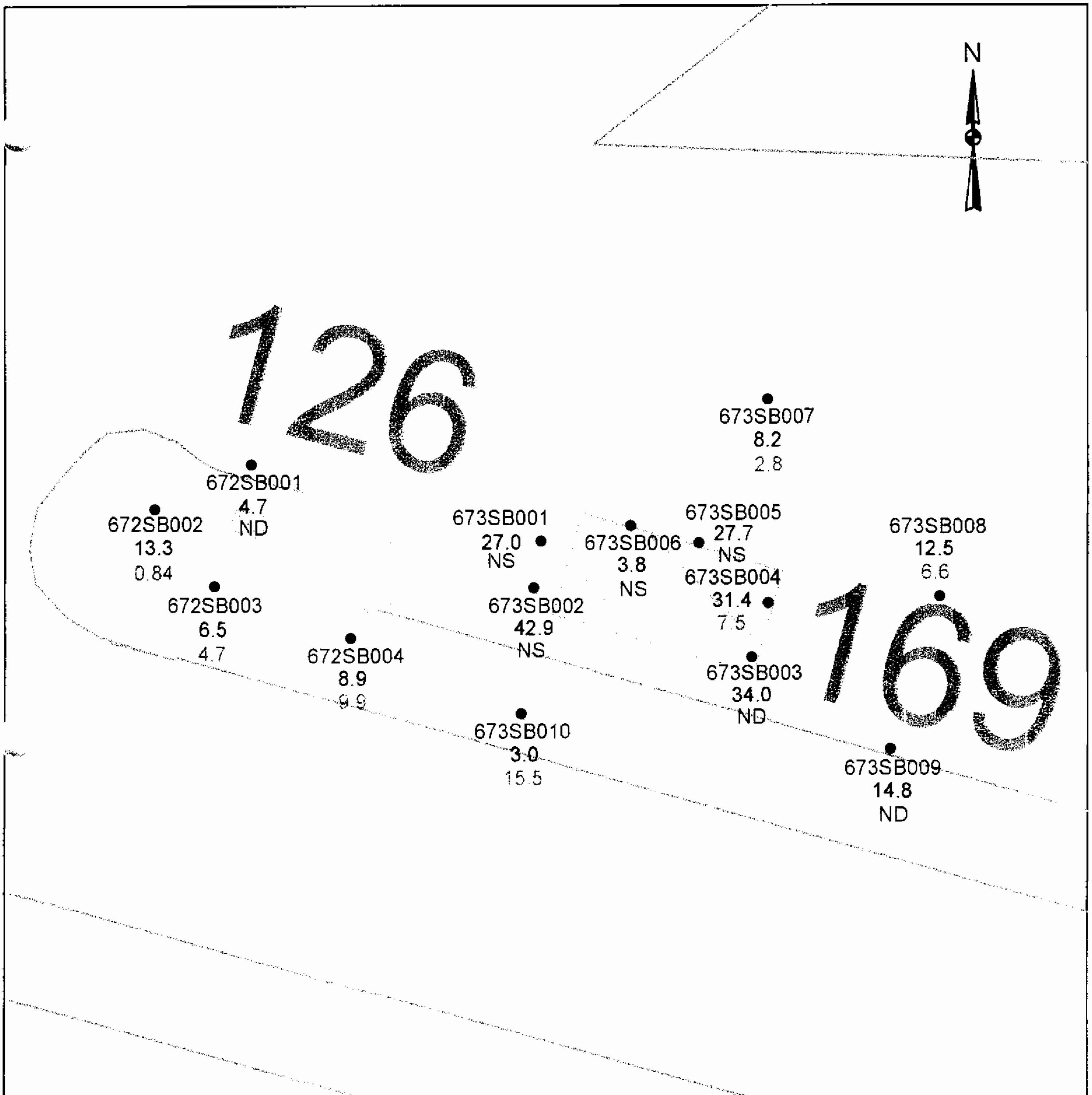
SCALE

10 0 10 20 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.2.3
ZONE I
AOC 672 & 673
BETA-BHC
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=NA RBC=350 UG/KG SSL=1.3 UG/KG



LEGEND

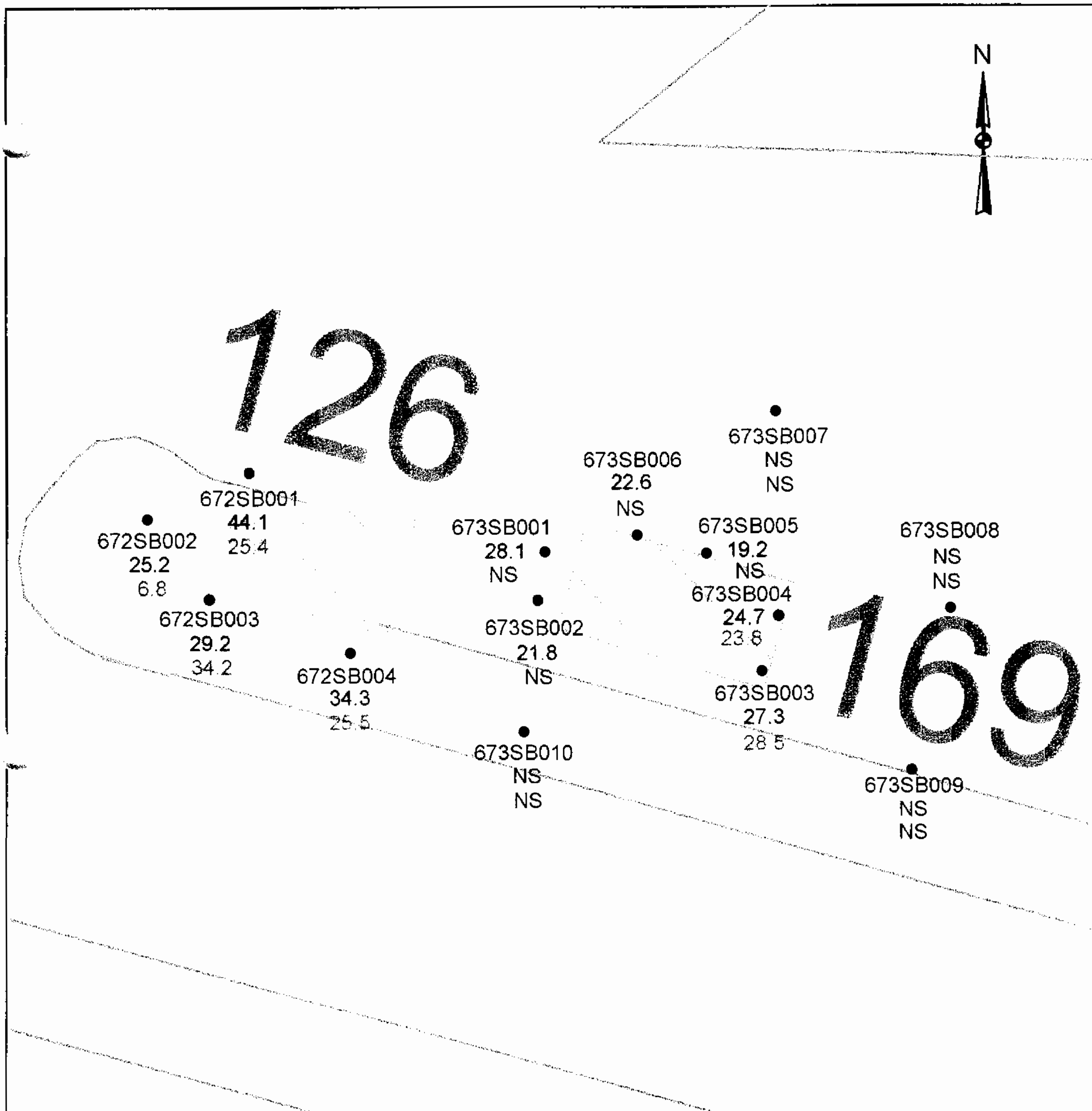
- ■ MONITORING WELL LOCATION
- ● ZONE I SOIL BORING LOCATION
- **12.30** ZONE I SURFACE SOIL CONC. (MG/KG)
- 12.30 ZONE I SUBSURFACE SOIL CONC. (MG/KG)
- *12.30* MAXIMUM QUARTERLY GW CONC. (UG/L)
- NS NO SAMPLE TAKEN
- ND NON DETECT

SCALE
10 0 10 20 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.2.4
ZONE I
AOC 672 & 673
ARSENIC
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=50 UG/L RBC=.43 MG/KG SSL=15 MG/KG



LEGEND

■ MONITORING WELL LOCATION
● ZONE I SOIL BORING LOCATION
12.30 ZONE I SURFACE SOIL CONC. (MG/KG)
12.30 ZONE I SUBSURFACE SOIL CONC. (MG/KG)
12.30 MAXIMUM QUARTERLY GW CONC. (UG/L)
NS NO SAMPLE TAKEN
ND NON DETECT

SCALE
10 0 10 20 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.2.5
ZONE I
AOC 672 & 673
CHROMIUM
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=100 UG/L RBC=39 MG/KG SSL=19 MG/KG

10.2.4.2 Soil-to-Air Cross-Media Transport

Table 10.2.5 lists the VOCs detected in surface soil samples collected at AOCs 672/673, along with corresponding soil-to-air volatilization screening levels. No volatiles were detected that exceeded applicable screening levels, and the migration pathway therefore is invalid.

10.2.4.3 Fate and Transport Summary

Two organic constituents – alpha-BHC and beta-BHC – were detected in the AOC 673 surface soil at concentrations exceeding groundwater protection SSLs. Alpha-BHC and beta-BHC were detected in one surface soil sample each. Neither organic was detected in any of the subsurface soil samples. Since the presence of alpha-BHC and beta-BHC at AOC 673 is not consistent with historical activities at this site, the source of these constituents at this site is unclear. The limited detection for alpha-BHC and beta-BHC in the surface soil, and the absence of detection in the subsurface soil, indicate that the contaminants are immobilized in the surface soil and that the soil-to-groundwater migration pathway is invalid.

Two inorganics, arsenic and chromium (total), were detected at concentrations exceeding their respective SSLs in both surface soil and subsurface soil. Arsenic was detected above the SSL in five surface soil samples and in one subsurface soil sample. Chromium was detected above the SSL in all 10 surface soil samples and in five of six subsurface soil samples. However, the subsurface arsenic exceedance and all of the chromium exceedances were below the zone-specific background and are therefore considered to be within the natural range of occurrence. While these concentrations may be above a theoretical SSL, they are eliminated from further consideration in this assessment in that they are not associated with the site as a source.

The soil-to-air pathway is unsubstantiated by the data at this site and is considered invalid.

10.2.5 Human Health Risk Assessment

10.2.5.1 Site Background and Investigative Approach

The purpose of the investigation at AOCs 672 and 673 was the assessment of soil potentially affected by past site activities. AOC 672 is a substation located in Building 126, containing transformer and switch gear to support the electrical grid. The facility dates from the World War II era with a modification in 1950. AOC 673 includes the Paint and Oil Storage Building 169. The building was once used to store paint, oils, solvents, and other support materials. In later years it was used to store fire-fighting equipment. The combined AOC 672/673 area is located in a paved parking area between Piers P and Q.

Soil was sampled in two rounds at AOCs 672/673 from the locations shown on Figure 10.2.1. All 10 first-round proposed upper-interval samples were collected. Six of the proposed first-round lower-interval samples were collected. Four lower-interval samples were not collected because the water table was encountered at less than 5 feet bgs. All samples were submitted for analysis of the standard suite of parameters, which includes VOC, SVOCs, pesticides, PCBs, metals, and cyanide at DQO Level III. Two first-round upper-interval duplicate samples were submitted for Appendix IX analysis at DQO Level IV. One upper-interval sample was also analyzed for the physical parameters CEC, chloride, sulfur, ammonia, nitrate/nitrite, phosphorus, TOC, and total moisture. Second-round sampling was performed at AOC 673 to further delineate arsenic contamination discovered during the first sampling round. No second-round samples were collected at AOC 672. Four second-round soil borings (673SB007 through 673SB010) were advanced at AOC 673. Upper and lower-interval samples were collected from each boring and analyzed for arsenic only. One second-round upper-interval duplicate sample, collected at boring 673SB010, was also analyzed for arsenic only. No groundwater sampling was performed in conjunction with the combined AOC 672/673 RFI.

10.2.5.2 COPC Identification

Based on the screening comparisons described in Section 7 of this RFI and presented in Table 10.2.7, the focus of this HHRA is on two COPCs, arsenic and chromium. Arsenic and chromium were also identified as having concentrations consistently higher than background based on the results of Wilcoxon rank sum test analyses. Wilcoxon rank sum test analysis did not identify any other COPCs that had been screened out on the basis of background comparisons only. Aluminum was detected at maximum concentrations exceeding its RBC but not exceeding its background concentration. Therefore, this inorganic was eliminated from further consideration in the AOCs 672/673 HHRA.

10.2.5.3 Exposure Assessment

Exposure Setting

AOC 672 is an electrical substation located in Building 126. The facility dates from the World War II era with a modification in 1950. AOC 673 includes the Paint and Oil Storage Building 169. The building was used to store paint, oils, solvents, and other support materials. The combined AOC 672/673 area is located in a paved parking area between Piers P and Q. This combined AOC is located in an area slated to become a marine cargo terminal, according to current base reuse plans. The paved surface would prevent direct contact with soil and would inhibit migration of potential contaminants to groundwater or air. The site is surrounded by a fence which inhibits access to potential trespassers. All potable water is provided through the city's water supply. Groundwater is not currently used as potable or process water, nor is such use anticipated in the future.

Potentially Exposed Populations

Potentially exposed populations are current and future site workers, hypothetical future site residents, and adolescent trespassers. Future site resident and future site worker exposure scenarios were addressed quantitatively in this risk assessment. The hypothetical future site resident scenario was built on the premise that existing features would be removed and replaced

Table 10.2.7
Chemicals Present in Site Samples
AOCs 672/673 - Surface Soil
Charleston Naval Complex
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration Residential RBC	Screening Concentration Background	Units	Number Exceeding RBC	Number Exceeding Background
Inorganics													
Aluminum (Al)		10	10	5510	17900	9111	NA	NA	7800	27400	MG/KG	6	
Arsenic (As)	*	14	14	2.95	42.9	17	NA	NA	0.43	21.6	MG/KG	14	5
Barium (Ba)		10	10	13.3	34.6	19.9	NA	NA	550	54.2	MG/KG		
Beryllium (Be)		2	10	0.31	0.44	0.375	0.24	0.41	16	0.95	MG/KG		
Cadmium (Cd)		1	10	1.1	1.1	1.1	0.52	0.71	7.8	0.61	MG/KG		1
Calcium (Ca)	N	10	10	15100	85300	43540	NA	NA	NA	NA	MG/KG		
Chromium (Cr) (Total)	*	10	10	19.2	44.1	27.6	NA	NA	39	34.5	MG/KG	1	1
Cobalt (Co)		4	10	1.7	2.35	2.03	1.5	2.1	470	5.8	MG/KG		
Copper (Cu)		10	10	6	30.9	14.8	NA	NA	310	240	MG/KG		
Iron (Fe)	N	10	10	4990	7860	6174	NA	NA	NA	NA	MG/KG		
Lead (Pb)		10	10	11.1	225	45.9	NA	NA	400	203	MG/KG		1
Magnesium (Mg)	N	10	10	1210	4200	2443	NA	NA	NA	NA	MG/KG		
Manganese (Mn)		10	10	37.6	100	58.1	NA	NA	160	419	MG/KG		
Mercury (Hg)		3	10	0.16	0.34	0.227	0.12	0.17	2.3	0.47	MG/KG		
Nickel (Ni)		10	10	6	12.3	8.72	NA	NA	160	23.9	MG/KG		
Potassium (K)	N	6	10	1040	1380	1187	727	984	NA	NA	MG/KG		
Selenium (Se)		9	10	0.595	1.1	0.826	0.53	0.71	39	1.49	MG/KG		
Sodium (Na)	N	2	10	414	860	637	362	825	NA	NA	MG/KG		
Tin (Sn)		9	10	1.1	2.9	1.91	0.95	1.2	4700	7.5	MG/KG		
Vanadium (V)		10	10	14.1	34.4	20	NA	NA	55	113	MG/KG		
Zinc (Zn)		10	10	40.75	321	103	NA	NA	2300	206	MG/KG		1
Herbicides													
2,4-D		1	2	19	19	19	120	120	78000	NA	µG/KG		
Pesticides													
4,4'-DDD		5	10	6.3	28	12.7	4.3	5.8	2700	NA	µG/KG		
4,4'-DDE		10	10	8.2	240	80.2	NA	NA	1900	NA	µG/KG		
4,4'-DDT		7	10	4.2	220	59	4.2	4.7	1900	NA	µG/KG		
alpha-BHC		1	10	1.2	1.2	1.2	1.2	4.2	100	NA	µG/KG		
beta-BHC		1	10	3.2	3.2	3.2	1.2	1.7	350	NA	µG/KG		
Chlordane		1	10	7.9	7.9	7.9	4.8	6.8	1800	NA	µG/KG		
Endosulfan sulfate		1	10	4	4	4	2.5	3.2	47000	NA	µG/KG		
Endrin		1	10	5	5	5	3.1	4.1	2300	NA	µG/KG		
Endrin aldehyde		1	10	2.4	2.4	2.4	1.2	1.7	2300	NA	µG/KG		
Heptachlor		1	10	1.4	1.4	1.4	1.2	1.7	140	NA	µG/KG		
Heptachlor epoxide		1	10	20	20	20	1.2	1.7	70	NA	µG/KG		
Methoxychlor		1	10	16	16	16	4.2	5.3	39000	NA	µG/KG		

Table 10.2.7
Chemicals Present in Site Samples
AOCs 672/673 - Surface Soil
Charleston Naval Complex
Charleston, South Carolina

Parameter	Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration Residential RBC	Screening Concentration Background	Units	Number Exceeding RBC	Number Exceeding Background
Semivolatile Organics												
bis(2-Ethylhexyl)phthalate (BEHP)	2	10	59	240	150	890	1300	46000	NA	μG/KG		
Di-n-butylphthalate	5	10	66	240	119	750	1200	780000	NA	μG/KG		
Fluoranthene	1	10	88	88	88	1100	1600	310000	NA	μG/KG		
Phenanthrene	1	10	83	83	83	740	1100	230000	NA	μG/KG		
Pyrene	2	10	53	61	57	870	1200	230000	NA	μG/KG		
Volatile Organics												
Acetone	5	10	52	150	108	110	150	780000	NA	μG/KG		
Toluene	4	10	4	7	5.5	21	25	1600000	NA	μG/KG		
TCDD Equivalents												
Dioxin	2	2	0.0065	0.014	0.01	NA	NA	1000	NA	NG/KG		

Notes:
* - Indicates chemical was identified as a COPC
N - Indicates chemical is an essential nutrient
SQL - Sample quantitation limit
RBC - Risk-based concentration
μG/KG - micrograms per kilogram
MG/KG - milligrams per kilogram
NG/KG - nanograms per kilogram
NA - Not applicable or not available

with dwellings. The future resident child scenario was considered to be conservatively representative of the adolescent trespasser.

The future site worker scenario assumed continuous exposure to surface soils. Exposure for current site workers would be less than this because the existing pavement prevents direct contact with surface soil. Therefore, future worker scenario is considered to be conservatively representative of current site worker exposure.

Exposure Pathways

Exposure pathways for the hypothetical future site residents are dermal contact and incidental ingestion of surface soils. The exposure pathways for future site workers are the same with respect to soil. In addition, the future site worker scenario assumed continuous exposure to surface soils. Uniform exposure was assumed for all sample locations. Table 10.2.8 presents the justification for assessing particular exposure pathways in this HHRA.

Exposure Point Concentrations

As discussed in Section 7 of this RFI, UCLs were calculated for datasets consisting of at least 10 samples. The arsenic and chromium UCLs calculated for surface soil are presented in Table 10.2.9. Because the UCLs did not exceed the maximum reported concentration, the UCLs were applied as the EPCs to estimate soil related exposures.

Quantification of Exposure

CDIs for ingestion and dermal contact with soils are shown in Tables 10.2.10 and 10.2.11, respectively.

Table 10.2.8
AOCs 672 and 673
Exposure Pathways Summary

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Current Land Uses			
Current Users (Site Workers)	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	This exposure pathway was considered insignificant compared to the other pathways.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Shallow groundwater is not currently used as a source of potable or non-residential water at combined AOC 672/673.
	Shallow groundwater, Inhalation of volatilized shallow groundwater contaminants	No	Shallow groundwater is not currently used as a source of potable or non-residential water at combined AOC 672/673.
	Soil, Incidental ingestion	No (Qualified)	Future site use is considered conservatively representative of current site use.
	Soil, Dermal contact	No (Qualified)	Future site use is considered conservatively representative of current site use.
Future Land Uses			
Future Site Residents (Child and Adult), Future Site Worker	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	This exposure pathway was considered insignificant compared to the other pathways.
	Shallow groundwater, ingestion of contaminants during potable or general use	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Shallow groundwater, Inhalation of volatilized contaminants during domestic use	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Soil, Incidental ingestion	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.
	Soil, Dermal contact	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.
	Wild game or domestic animals, Ingestion of tissue impacted by media contamination	No	Hunting/taking of game and/or raising livestock is prohibited within the Charleston, South Carolina city limits.
	Fruits and vegetables, Ingestion of plant tissues grown in media	No	The potential for significant exposure via this pathway is low relative to that of other exposure pathways assessed.

1

Table 10.2.9
Statistical Analysis of COPCs
Surface Soil at AOCs 672/673
Charleston Naval Complex
Charleston, South Carolina

COPC	n	Natural Log Transformed mean	SD	H-stat	UCL (mg/kg)	MAX (mg/kg)	EPC (mg/kg)	
Arsenic	14	2.518	0.871	2.595	34.0	42.9	34.0	UCL
Chromium	10	3.292	0.239	1.918	32.3	44.1	32.3	UCL

Notes:

mean arithmetic mean of the logtransformed data
n number of samples analyzed
SD standard deviation for a sample of data
H-stat "H" statistic from Gilbert 1987; cuboidal interpolation was used to determine the value in accordance with *USEPA Supplemental Guidance to RAGS*, Calculating the Concentration Term
EPC exposure point concentration
UCL 95 percentile upper confidence level mean
MAX maximum reported concentration

Table 10.2.10
Chronic Daily Intakes
Incidental Ingestion of Surface Soil
AOCs 672/673
Charleston Naval Complex
Charleston, South Carolina

Chemical	Fraction Ingested from Contaminated Source*	Exposure Point Concentration (mg/kg)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident LWA C-CDI (mg/kg-day)	Future Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Arsenic	1	34.0	4.65E-05	4.34E-04	5.32E-05	1.66E-05	5.93E-06
Chromium	1	32.3	4.42E-05	4.12E-04	5.05E-05	1.58E-05	5.64E-06

Notes:

*	Reflects the estimated fraction of the site impacted by the corresponding COPC.
LWA	Lifetime-weighted average; used to calculate carcinogenic CDI, *RAGS Parts A and B*
CDI	Chronic daily intake
H-CDI	CDI for hazard quotient
C-CDI	CDI for excess cancer risk

Table 10.2.11
Chronic Daily Intakes
Dermal Contact with Surface Soil
AOCs 672/673
Charleston Naval Complex
Charleston, South Carolina

Chemical	Exposure Point Concentration (mg/kg)	Fraction Contacted from Contaminated Source *	Dermal Absorption Factor+	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident LWA C-CDI (mg/kg-day)	Future Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Arsenic	34.0	1	0.001	1.91E-06	6.30E-06	1.19E-06	1.36E-06	4.87E-07
Chromium	32.3	1	0.001	1.81E-06	5.98E-06	1.13E-06	1.29E-06	4.62E-07

Notes:
CDI Chronic daily intake
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
+ The dermal absorption factor was applied to the exposure point concentration to reflect the different trans-dermal migration of inorganic versus organic chemicals
* Reflects the estimated fraction of the site impacted by the corresponding COPC.
LWA Lifetime-weighted average

10.2.5.4 Toxicity Assessment

Toxicity assessment terms and methods are discussed in Section 7 of this report. Table 10.2.12 presents toxicological information specific to each COPC identified at AOCs 672/673. This information was used in the quantification of risk/hazard associated with soil contaminants. Brief toxicological profiles for each COPC are provided in the following paragraphs.

Arsenic exposure via the ingestion route causes darkening and hardening of the skin in chronically exposed humans. Inhalation exposure to arsenic causes neurological deficits, anemia, and cardiovascular effects (Klaasen, et al., 1986). USEPA set 0.3 μg/kg-day as the RfD for arsenic based on a NOAEL of 0.8 μg/kg-day in a human exposure study. The effects of arsenic on the nervous and cardiovascular systems are primarily associated with acute exposure to higher levels. Exposure to arsenic-containing materials has been shown to cause cancer in humans. Inhalation of these materials can lead to increased lung cancer risk, and ingestion of these materials is associated with increased skin cancer rates. Arsenic has been classified as a group A carcinogen by USEPA, who established the 1.5 $(mg/kg\text{-}day)^{-1}$ SF. As listed in IRIS, the basis for the classification is sufficient evidence from human data. An increased lung cancer mortality was observed in multiple human populations exposed primarily through inhalation. Also, increased mortality from multiple internal organ cancers (liver, kidney, lung, and bladder) and an increased incidence of skin cancer were observed in populations consuming drinking water high in inorganic arsenic. Human milk contains about 3 μg/L arsenic. The tap-water RBC for arsenic is 0.045 μg/L. As listed in IRIS, the critical effects of this chemical are hyperpigmentation, keratosis, and possible vascular complications. The uncertainty factor was determined to be 3 and the modifying factor was determined to be 1.

Chromium exists in two stable, natural forms: CrIII and hexavalent CrVI. Acute exposure to chromium can result in kidney damage following oral exposure, or damage to the nasal mucosa and septum following inhalation exposure. Chronic inhalation exposure to CrVI has resulted in

Table 10.2.12
Toxicological Reference Information
for Chemicals of Potential Concern
AOCs 672/673
Charleston Naval Complex
Charleston, South Carolina

	Non-Carcinogenic Toxicity Data								*Carcinogenic Toxicity Data*			
Chemical	**Oral Reference Dose (mg/kg-day)**	**Confidence Level**	**Critical Effect**	**Uncertainty Factor Oral**	**Inhalation Reference Dose (mg/kg-day)**	**Confidence Level**	**Critical Effect**	**Uncertainty Factor Inhalation**	**Oral Slope Factor (kg-day/mg)**	**Inhalation Slope Factor (kg-day/mg)**	**Weight of Evidence**	**Tumor Type**
Arsenic	0.0003 a	M	hyperpigmentation	3	NA	NA	NA	NA	1.5 a	15.1 a	A	various
Chromium III	1 a	L	NA	100/10	NA	NA	NA	NA	NA	NA a	D	NA
Chromium VI	0.005 a	L	NA	500	1E-07 c	NA	NA	NA	NA	41 b	A	lung

Notes:

a = Integrated Risk Information System (IRIS)
b = Health Effects Assessment Summary Tables (HEAST)
c = EPA NCEA - Cincinnati (provisional)
NA = Not applicable or not available
L = Low confidence
M = Medium confidence

kidney and respiratory tract damage, as well as excess lung cancer in both animals and humans following occupational exposure. Only CrVI is believed to be carcinogenic by inhalation (IRIS). Oral RfD values for CrIII and CrVI are 1.0 and 5E-03 (mg/kg-day), respectively. For CrVI, the RfD is based on liver toxicity in rats. For CrVI, the RfD is based on unspecified pathological changes observed in rat studies. In addition, CrVI is considered a group A carcinogen for inhalation exposures, and an inhalation SF of 41 $(mg/kg\text{-}day)^{-1}$ has been established for the hexavalent form. Vitamin supplements contain approximately 0.025 mg of chromium. As listed in IRIS, no critical effects were observed for CrIII. The uncertainty factor was 100 and the modifying factor was 10. As listed in IRIS, no critical effects were observed for CrVI. The uncertainty factor was 500 and the modifying factor was 1.

10.2.5.5 Risk Characterization

Surface Soil Pathways

Exposure to surface soil was evaluated under both residential and industrial (site worker) scenarios. For each scenario the incidental ingestion and dermal contact exposure pathways were evaluated. For noncarcinogenic contaminants evaluated for future site residents, hazard was computed separately to address child and adult exposures. Tables 10.2.13 and 10.2.14 present the computed carcinogenic risks and/or HQs associated with the incidental ingestion of and dermal contact with site surface soils, respectively.

Hypothetical Site Residents

The ingestion ILCR (based on the adult and child lifetime-weighted average) for AOC 672/673 surface soils is 8E-05, and the dermal pathway ILCR is 9E-06. The computed hazard indices for the adult and child resident were 0.2 and 2, respectively, for the soil ingestion pathway. The dermal contact pathway hazard indices were 0.03 and 0.1 for the adult resident and the child resident, respectively. Arsenic was the primary contributor to both risk and hazard estimates.

Table 10.2.13
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
AOCs 672/673
Charleston Naval Complex
Charleston, South Carolina

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used $(mg/kg\text{-}day)^{-1}$	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident LWA ILCR	Future Worker adult Hazard Quotient	Future Worker adult ILCR
Arsenic	0.0003	1.5	0.16	1.4	8.0E-05	0.055	8.9E-06
Chromium	0.005	ND	0.0088	0.082	ND	0.0032	ND
SUM Hazard Index/ILCR			0.2	2	8E-05	0.06	9E-06

Notes:
NA Not available
ND Not Determined due to lack of available information
LWA Lifetime-weighted average; used to calculate excess carcinogenic risk derived from *RAGS Part A*
ILCR Incremental lifetime excess cancer risk

Table 10.2.14
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
AOCs 672/673
Charleston Naval Complex
Charleston, South Carolina

Chemical	Dermal Adjustment*	Oral RfD Used (mg/kg-day)	Oral SF Used $(mg/kg\text{-}day)^{-1}$	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident LWA ILCR	Future Worker adult Hazard Quotient	Future Worker adult ILCR
Arsenic	0.2	6E-05	7.5	0.032	0.10	9.0E-06	0.023	3.6E-06
Chromium	0.2	0.001	ND	0.0018	0.0060	ND	0.0013	ND
SUM Hazard Index/ILCR				0.03	0.1	9E-06	0.02	4E-06

Notes:

* Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)

ND Not determined due to lack of available information

LWA Lifetime-weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A.

ILCR Incremental lifetime excess cancer risk

Future Site Workers

Site worker ILCRs are 9E-06 and 4E-06 for the ingestion and dermal contact pathways, respectively. The hazard indices for both pathways were less than 0.1. Arsenic was the primary contributor to risk estimates.

The AOC 672/673 area is almost entirely covered by an asphalt parking lot. Current site users have little chance of exposure to affected surface soil. Should the existing pavement remain under future use scenarios, the risk/hazard projections presented above would be gross overestimates.

COCs Identified

USEPA has established a generally acceptable risk range of 1E-04 to 1E-06, and a hazard index threshold of 1.0 (unity). As recommended by SCDHEC, a COC was considered to be any chemical contributing to a cumulative risk level of 1E-06 or greater and/or a cumulative hazard index above 1.0, and whose individual ILCR exceeds 1E-06 or whose hazard quotient exceeds 0.1. For carcinogens, this approach is relatively conservative, since a cumulative risk level of 1E-04 (and individual ILCR of 1E-06) is recommended by USEPA Region IV as the trigger for establishing COCs. The COC selection algorithm presented was used to provide a more comprehensive evaluation of chemicals contributing to carcinogenic risk or noncarcinogenic hazard during the development of remedial goal options. Table 10.2.15 presents the COCs identified for the AOC 672/673 surface soil.

Hypothetical Site Residents (future land use)

Arsenic was identified as the sole soil pathway COC based on its contribution to cumulative ILCR and HI projections.

Table 10.2.15
Summary of Risk and Hazard-based COCs
AOCs 672/673
Charleston Naval Complex
Charleston, South Carolina

Medium	Exposure Pathway		Future Resident Adult Hazard Quotient	Future Resident Child Hazard Quotient	Future Resident LWA ILCR	Current Site Worker Hazard Quotient	Current Site Worker ILCR	Identification of COCs		
Surface Soil	Incidental Ingestion	Arsenic	0.16	1.4	8.0E-05	0.055	8.9E-06	1	2	4
		Chromium	0.0088	0.082	ND	0.0032	ND			
	Dermal	Arsenic	0.032	0.10	9.0E-06	0.023	3.6E-06	1	2	4
		Chromium	0.0018	0.0060	ND	0.0013	ND			
Sum of all Pathways			0.2	2	9E-05	0.08	1E-05			

Notes:
ND = not determined due to the lack of available information
ILCR = incremental excess lifetime cancer risk
HI = hazard index
LWA = Lifetime-weighted average
1- Chemical is a COC by virtue of projected future child resident child noncarcinogenic hazard.
2- Chemical is a COC by virtue of projected future resident lifetime ILCR.
4- Chemical is a COC by virtue of projected site worker ILCR.

Future Site Workers (current land use)

Arsenic was identified as the sole soil pathway COC based on its contribution to cumulative ILCR projections.

COC Concentrations

To facilitate evaluation of the extent of COC concentrations, a comparison was made to the arsenic background concentration. Arsenic was the sole COC identified for surface soil and was detected in each of 14 samples collected, with a maximum concentration of 42.9 mg/kg. This maximum concentration exceeded the background concentration of 21.6 mg/kg computed for Zone I surface soil. The overall onsite arsenic data set was statistically higher than background as determined by Wilcoxon rank sum test analysis. A detailed evaluation of surface soil arsenic data shows that concentrations were generally elevated in the 10 samples collected at AOC 673, with a mean of approximately 20.5 mg/kg. The concentrations reported in the four AOC 672 samples had a mean of 8.35 mg/kg.

10.2.5.6 Risk Uncertainty

Characterization of Exposure Setting and Identification of Exposure Pathways

The potential for high bias in the exposure assessments is introduced through the exposure setting and pathway selection due to the highly conservative assumptions (i.e., future residential use) recommended by USEPA Region IV. The exposure assumptions made in the site worker scenario are highly conservative and would tend to overestimate exposure. Current site workers are not exposed to site groundwater. The majority of the AOC 672/673 area is covered by asphalt, thus precluding exposure to affected surface soil.

Residential use of the site is not expected or likely, based on current site uses and the nature of surrounding buildings. Current reuse plans call for continued commercial/industrial use of Zone I, and AOCs 672 and 673 are slated to become a marine cargo terminal. If this area were to be used as a residential site, the buildings would be demolished, asphalt surface removed, and the surface soil conditions would likely change. For example, the soils would be covered with landscaping soil and/or a house. Consequently, exposure to current surface soil conditions would not be likely under a true future residential scenario. These factors indicate that exposure pathways assessed in this HHRA generally overestimate the risk and hazard posed to current site workers and future site residents.

Determination of Exposure Point Concentration

The exposure point concentration was set equal to the 95% UCL. This is a conservative assumption since it is unlikely that the 95% UCL is exceeded by the true mean concentration.

Frequency of Detection and Spatial Distribution

Arsenic, the sole COC identified at AOC 672/673, was detected in each of the 14 surface soil samples collected. In general, the concentrations reported in AOC 672 samples were considerably lower than those at AOC 673. The apparent bimodal pattern for arsenic suggests that former operations at AOC 673 may have been a source Although not consistent with historical use.

Quantification of Risk/Hazard

The uncertainty inherent in the risk assessment process is great. In addition, many site-specific factors affect the uncertainty of this assessment and cause upward bias in the risk and hazard estimates. Exposure pathway-specific sources of uncertainty are discussed below.

Of the CPSSs screened and eliminated from formal assessment, none was reported at a concentration close to its corresponding RBC (i.e., within approximately 10% of the RBC). This minimizes the likelihood of potentially significant cumulative risk/hazard based on the eliminated CPSSs. Aluminum exceeded its RBC, but it was eliminated from formal assessment because it did not exceed its background concentration.

Although the future land use at this site is unknown, both the worker and residential exposure scenarios were assessed in this HHRA. As previously discussed, these scenarios lead to overestimates of risk and/or hazard.

Central tendency analysis was not formally performed for AOC 672/673 surface soil, but a simplified approach was taken to assess the potential influences of CT assumptions. The CT assumption for residential exposure duration is nine years, compared to the 30 year assumption for RME. The CT exposure frequency assumption is 234 days/year, compared to 350 days/year RME. If all other exposure assumptions remain fixed, application of the CT exposure duration and frequency would result in risk projections 80% below the RME. At CT, the residential surface soil pathway-related risk (incidental ingestion and dermal contact) would drop from 9E-05 to 2E-06. However, this is still marginally above the 1E-06 point of departure. The cumulative hazard index for ingestion and dermal contact pathways would fall below unity under CT assumptions.

Background-Related Risk

Soil

Aluminum was detected in AOC 672/673 surface soil at concentrations above its RBC. This element was eliminated from consideration in the risk assessment based on comparison to its background value. It is not unusual for naturally occurring or background concentrations of some elements to exceed risk-based concentrations. The following addresses the risk/hazard associated with the background concentration of aluminum.

The maximum surface soil concentration of aluminum (17,900 mg/kg) for AOC 672/673 equates with hazard quotients of 0.3 and 0.01 for the residential child and site worker, respectively. The background value for aluminum (27,400 mg/kg) results in hazard quotients of 0.4 and 0.02 for the residential child and site worker, respectively.

10.2.5.7 Risk Summary

The risk and hazard posed by contaminants at AOC 672/673 were assessed for the hypothetical future site worker and hypothetical future site resident under reasonable maximum exposure assumptions. This (HHRA) assessed the incidental ingestion and dermal contact pathways for surface soils. Table 10.2.16 presents the risk summary for each pathway/receptor group evaluated.

Soil — Residential Scenario

The residential soil pathway COC identified for AOC 672/673 is arsenic. Figures 10.2.6 and 10.2.7 show point risk and hazard estimates based on surface soil exposure pathways under a future residential scenario. Table 10.2.17 summarizes the risk and hazard contribution of each COPC at each sample location.

The point risk map is based on the unlikely assumption that a future site resident will be chronically exposed to specific points. Exposure to surface soil conditions would more likely be the result of uniform exposure to the soil conditions of the entire site (or exposure unit area) rather than specific points. Given this, the risk maps and summary table are useful to illustrate spatial distribution of the chemicals driving risk estimates.

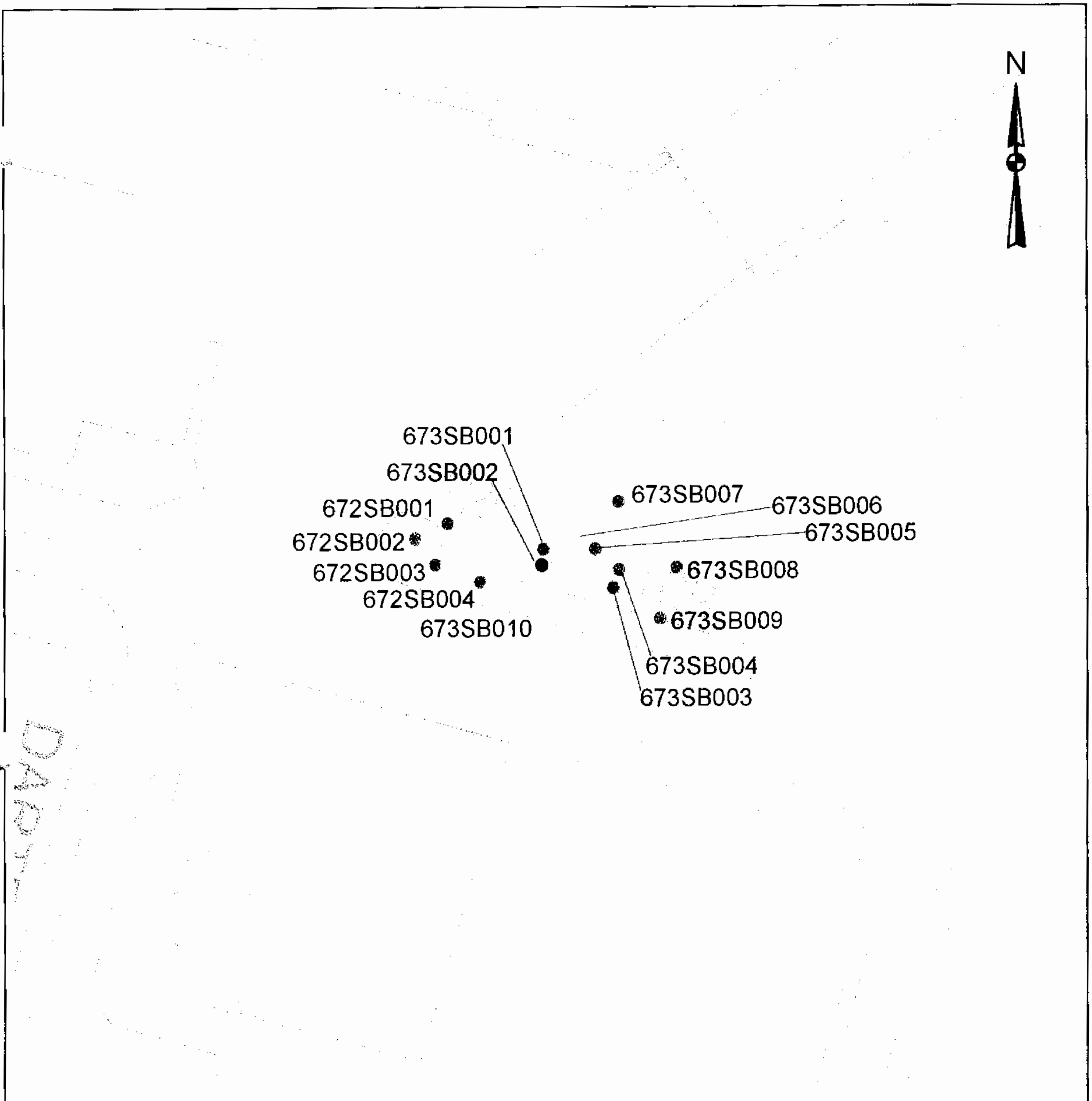
All sample locations yielded ILCRs that were greater than 1E-06. Arsenic was the only contributor to risk. Risk estimates range from 7E-06 (673SB010) to 1E-04 (673SB002).

Arsenic was a primary contributor to hazard estimates at the locations at combined AOC 672 that yielded a hazard index above unity (673SB001 through 673SB005). Hazard index estimates ranged from 0.1 (673SB010) to 2 (673SB002), with a mean hazard estimate of 0.9.

Table 10.2.16
Summary of Risk and Hazard for AOCs 672/673
Charleston Naval Complex
Charleston, South Carolina

Medium	Exposure Pathway	HI Resident (Adult)	HI Resident (Child)	ILCR Resident (LWA)	HI (Worker)	ILCR (Worker)
Surface Soil	Incidental Ingestion	0.2	1.5	8E-05	0.06	9E-06
	Dermal Contact	0.03	0.1	9E-06	0.02	4E-06
Sum of All Pathways		0.2	2	9E-05	0.08	1E-05

Notes:
ND = not determined due to the lack of available information
ILCR = incremental excess lifetime cancer risk
HI = hazard index
LWA = Lifetime-weighted average



LEGEND

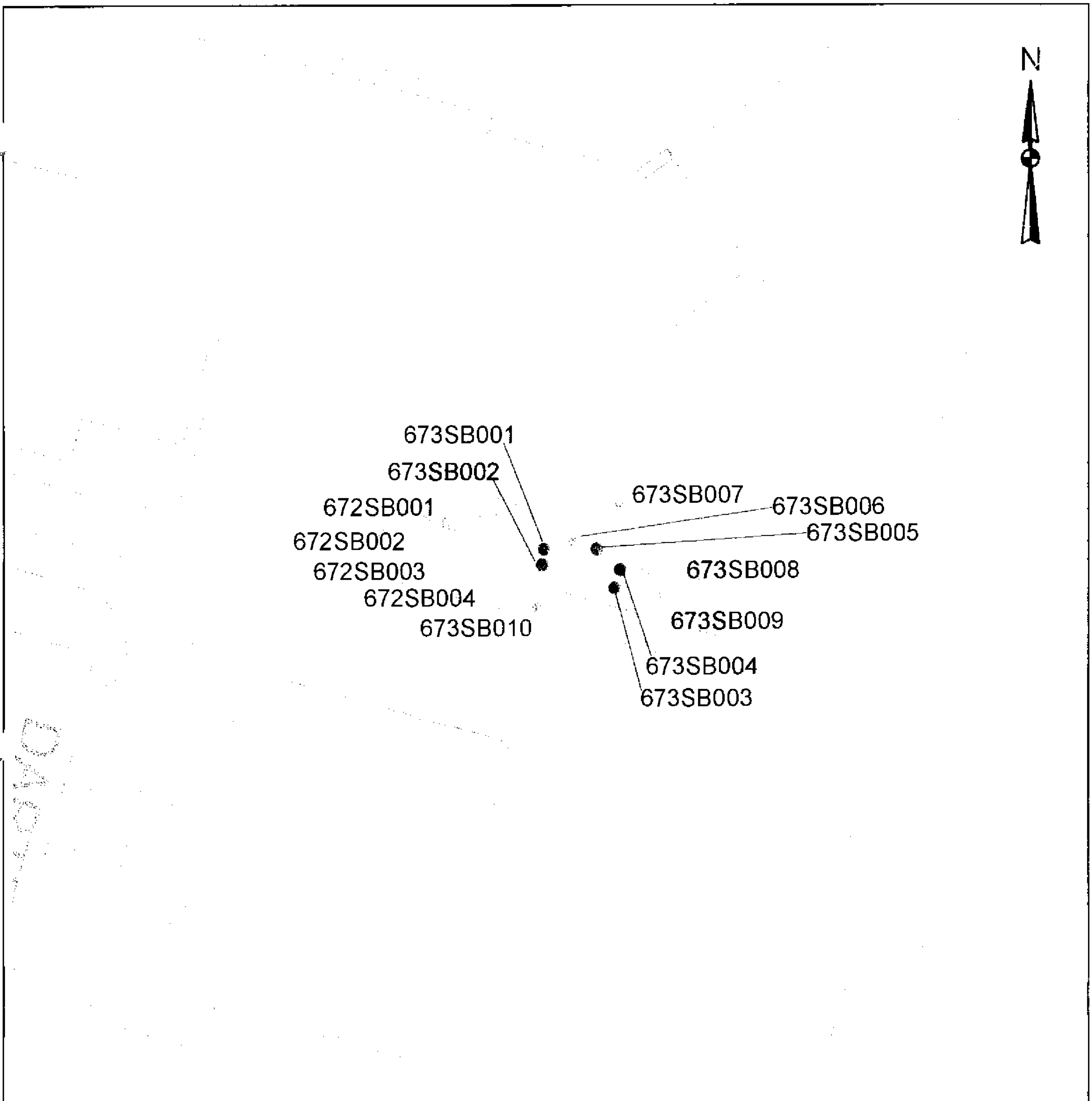
- NO COPCs
- < 1E-6
- 1E-6 to 5E-6
- 5E-6 to 1E-5
- 1E-5 to 1E-4
- > 1E-4

60 0 60 120 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.2.6
ZONE I
AOCs 672 & 673

SURFACE SOIL POINT RISK
RESIDENTIAL SCENARIO



LEGEND

- NO COPCs
- 0 to 0.1
- 0.1 to 0.5
- 0.5 to 1.0
- 1.0 to 3.0
- > 3.0

60 0 60 120 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.2.7
ZONE I
AOCs 672 & 673

SURFACE SOIL HAZARD INDEX
RESIDENTIAL SCENARIO

Table 10.2.17
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
AOCs 672/673
Charleston Naval Complex
Charleston, South Carolina

AOC	Location	Parameter	Concentration	Units	Hazard Index	Risk (E-06)
672	B001	Arsenic (As)	4.7000	MG/KG	0.215	12.28
672	B001	Chromium (Cr)	44.1	MG/KG	0.121	NA
				Total	0.336	12.28
672	B002	Arsenic (As)	13.3	MG/KG	0.608	34.74
672	B002	Chromium (Cr)	25.2	MG/KG	0.069	NA
				Total	0.677	34.74
672	B003	Arsenic (As)	20	MG/KG	0.914	52.24
672	B003	Chromium (Cr)	28.4	MG/KG	0.078	NA
				Total	0.992	52.24
672	B004	Arsenic (As)	8.9	MG/KG	0.407	23.25
672	B004	Chromium (Cr)	34.3	MG/KG	0.094	NA
				Total	0.501	23.25
673	B001	Arsenic (As)	27	MG/KG	1.234	70.52
673	B001	Chromium (Cr)	28.1	MG/KG	0.077	NA
				Total	1.311	70.52
673	B002	Arsenic (As)	42.9	MG/KG	1.961	112.05
673	B002	Chromium (Cr)	21.8	MG/KG	0.060	NA
				Total	2.021	112.05
673	B003	Arsenic (As)	34.5	MG/KG	1.577	90.11
673	B003	Chromium (Cr)	27	MG/KG	0.074	NA
				Total	1.651	90.11
673	B004	Arsenic (As)	31.4	MG/KG	1.435	82.02
673	B004	Chromium (Cr)	24.7	MG/KG	0.068	NA
				Total	1.503	82.02
673	B005	Arsenic (As)	27.7	MG/KG	1.266	72.35
673	B005	Chromium (Cr)	19.2	MG/KG	0.053	NA
				Total	1.319	72.35
673	B006	Arsenic (As)	3.7	MG/KG	0.169	9.66
673	B006	Chromium (Cr)	22.5	MG/KG	0.062	NA
				Total	0.231	9.66
673	B007	Arsenic (As)	8.2	MG/KG	0.375	21.42
				Total	0.375	21.42
673	B008	Arsenic (As)	12.5	MG/KG	0.571	32.65
				Total	0.571	32.65
673	B009	Arsenic (As)	14.8	MG/KG	0.676	38.66
				Total	0.676	38.66
673	B010	Arsenic (As)	2.95	MG/KG	0.135	7.71
				Total	0.135	7.71

Soil — Site Worker Scenario

The industrial soil pathway COC identified for AOC 672/673 is arsenic. Figure 10.2.8 gives point risk estimates based on soil exposure pathways under a future site worker/industrial scenario. Table 10.2.18 summaries the risk and hazard contribution of each COPC at each sample location.

All sample locations yielded ILCRs greater than 1E-06. Arsenic was the only contributor to risk. Risk estimates ranged from 1E-06 (673SB010) to 2E-05 (673SB002), with a mean risk estimate of 7E-06.

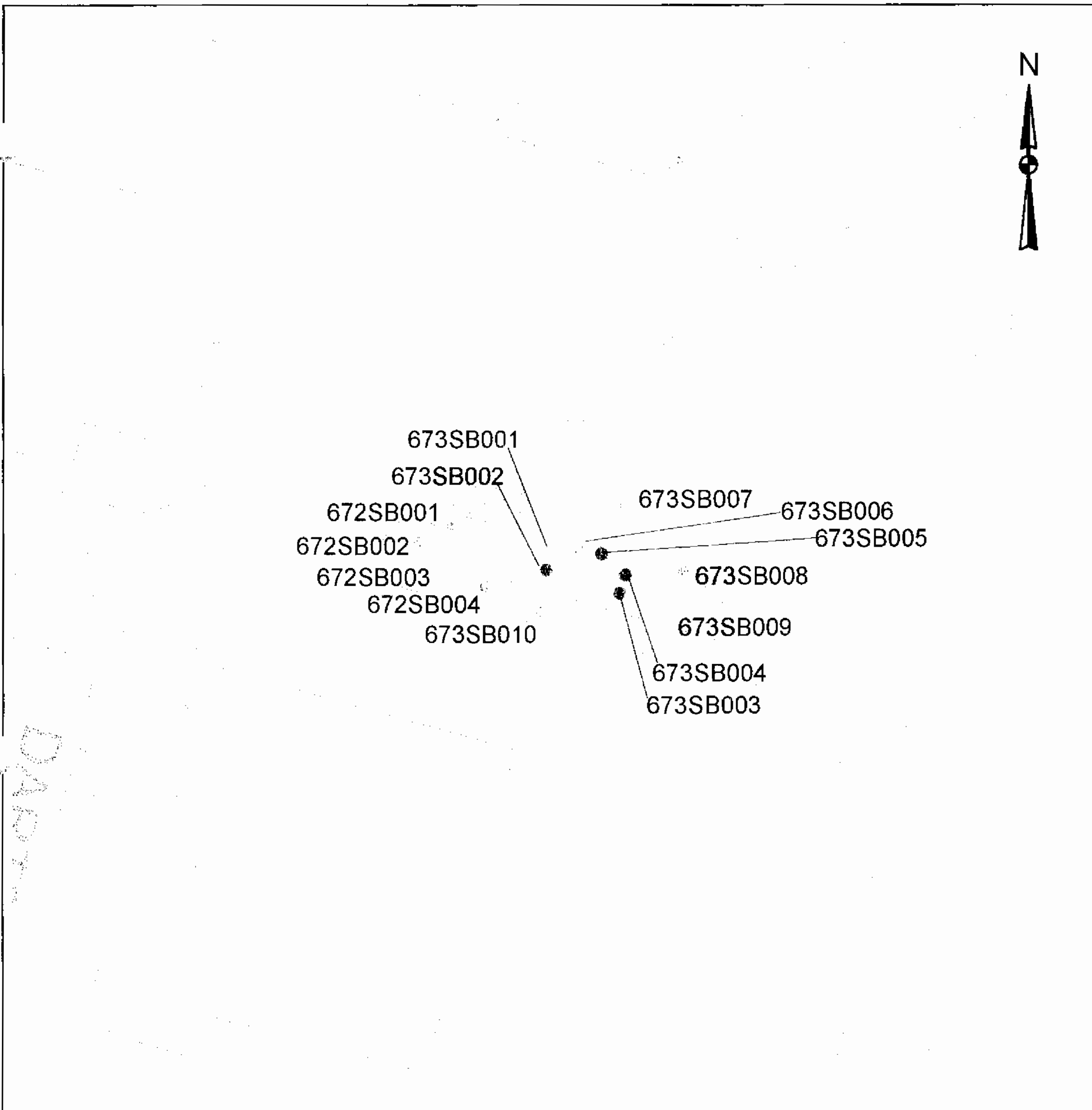
Arsenic was the sole contributor to hazard estimates at AOC 672/673; however, hazard indices did not exceed unity at any location for the industrial scenario. Hazard index estimated ranged from 0.01 (673SB010) to 0.1 (673SB002), with a mean hazard estimate of 0.04.

10.2.5.8 Remedial Goal Options

RGOs for carcinogens were based on the lifetime-weighted average future site resident and future site worker, as presented in Table 10.2.19. Hazard-based RGOs were calculated based on the hypothetical child resident or the site worker, as indicated on the table.

10.2.6 Corrective Measures Considerations

Based on the analytical results and the human health risk assessment for AOCs 672/673, COCs requiring further evaluation through the CMS process have been identified for surface soil. The site is in a moderately developed urban setting and risk to human health was evaluated under both the residential and industrial (site worker) scenarios. For these scenarios, the incidental ingestion and dermal contact exposure pathways were evaluated. Hazard was evaluated for noncarcinogenic contaminants through incidental ingestion and dermal contact as well.



LEGEND

- NO COPCs
- < 1E-6
- 1E-6 to 5E-6
- 5E-6 to 1E-5
- 1E-5 to 1E-4
- > 1E-4

60 0 60 120 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.2.8
ZONE I
AOCs 672 & 673

SURFACE SOIL POINT RISK
INDUSTRIAL SCENARIO

Table 10.2.18
Point Estimates of Risk and Hazard - Surface Soil Pathways
Industrial Scenario
AOCs 672/673
Charleston Naval Complex
Charleston, South Carolina

AOC	Location	Parameter	Concentration	Units	Hazard Index	Risk (E-06)
672	B001	Arsenic (As)	4.7000	MG/KG	0.011	1.74
672	B001	Chromium (Cr)	44.1	MG/KG	0.006	0.00
				Total	0.017	1.74
672	B002	Arsenic (As)	13.3	MG/KG	0.031	4.91
672	B002	Chromium (Cr)	25.2	MG/KG	0.003	0.00
				Total	0.034	4.91
672	B003	Arsenic (As)	20	MG/KG	0.046	7.39
672	B003	Chromium (Cr)	28.4	MG/KG	0.004	0.00
				Total	0.050	7.39
672	B004	Arsenic (As)	8.9	MG/KG	0.020	3.29
672	B004	Chromium (Cr)	34.3	MG/KG	0.005	0.00
				Total	0.025	3.29
673	B001	Arsenic (As)	27	MG/KG	0.062	9.98
673	B001	Chromium (Cr)	28.1	MG/KG	0.004	0.00
				Total	0.066	9.98
673	B002	Arsenic (As)	42.9	MG/KG	0.099	15.85
673	B002	Chromium (Cr)	21.8	MG/KG	0.003	0.00
				Total	0.102	15.85
673	B003	Arsenic (As)	34.5	MG/KG	0.079	12.75
673	B003	Chromium (Cr)	27	MG/KG	0.004	0.00
				Total	0.083	12.75
673	B004	Arsenic (As)	31.4	MG/KG	0.072	11.60
673	B004	Chromium (Cr)	24.7	MG/KG	0.003	0.00
				Total	0.076	11.60
673	B005	Arsenic (As)	27.7	MG/KG	0.064	10.24
673	B005	Chromium (Cr)	19.2	MG/KG	0.003	0.00
				Total	0.066	10.24
673	B006	Arsenic (As)	3.7	MG/KG	0.009	1.37
673	B006	Chromium (Cr)	22.5	MG/KG	0.003	0.00
				Total	0.012	1.37
673	B007	Arsenic (As)	8.2	MG/KG	0.019	3.03
				Total	0.019	3.03
673	B008	Arsenic (As)	12.5	MG/KG	0.029	4.62
				Total	0.029	4.62
673	B009	Arsenic (As)	14.8	MG/KG	0.034	5.47
				Total	0.034	5.47
673	B010	Arsenic (As)	2.95	MG/KG	0.007	1.09
				Total	0.007	1.09

Table 10.2.19
Remedial Goal Options Surface Soil
AOCs 672/673
Charleston Naval Complex
Charleston, South Carolina

Resident-based Remedial Goal Options*

Chemical	Slope Factor $(mg/kg\text{-}day)^{-1}$	Reference Dose (mg/kg-day)	EPC mg/kg	Hazard-Based Remedial Goal Options **3** mg/kg	**1** mg/kg	**0.1** mg/kg	Risk-Based Remedial Goal Options **1E-06** mg/kg	**1E-05** mg/kg	**1E-04** mg/kg	Background Concentration mg/kg
Arsenic	1.5	0.0003	34.0	66	22	2.2	0.38	3.8	38	21.6

Site Worker-based Remedial Goal Options

Chemical	Slope Factor $(mg/kg\text{-}day)^{-1}$	Reference Dose (mg/kg-day)	EPC mg/kg	Hazard-Based Remedial Goal Options **3** mg/kg	**1** mg/kg	**0.1** mg/kg	Risk-Based Remedial Goal Options **1E-06** mg/kg	**1E-05** mg/kg	**1E-04** mg/kg	Background Concentration mg/kg
Arsenic	1.5	0.0003	34.0	1305	435	43	2.7	27	271	21.6

Notes:

EPC exposure point concentration

* Resident-based remedial goal options were calculated based on the resident lifetime weighted average for carcinogens and the child resident for noncarcinogens. Site worker remedial goal options were base on the site worker scenario.

As recommended by SCDHEC, a COC is considered to be any chemical contributing to a cumulative risk level of 1E-06 or greater and/or a cumulative hazard index above 1.0, and whose individual risk exceeds 1E-06 or whose hazard quotient exceeds 0.1.

Arsenic was identified as a soil pathway COC for AOCs 672/673. Table 10.2.20 presents cumulative and COC-specific exposure risks and hazard quotients.

Risk-based remedial goals for surface soil are presented in Table 10.2.19. Potential corrective measures for soil are presented in Table 10.2.21.

Table 10.2.20
AOC 672/673
Cumulative and Chemical-Specific Exposure Risks and Hazard

	Risk		Hazard	
Chemical	**Industrial**	**Residential**	**Industrial**	**Residential**
Soil				
Arsenic	1.25E-5	8.9E-5	0.078	1.5
Cumulative	1.25E-5	8.9E-5	0.078	1.5

Table 10.2.21
AOCs 672/673
Potential Corrective Measures

Medium	Compounds	Potential Corrective Measures
Soil	Arsenic	a) No action b) Excavate, offsite disposal, and monitoring c) Containment/capping

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10.3 AOC 675, Fuel Oil Storage, (Facility NS-4); AOC 676, Former Incinerator (Building NS-2); and AOC 677, Grounds, (Building NS-2)

AOC 675 is a 25,000-gallon UST (Facility NS-4), installed in 1952. A 495-gallon oil/water separator is located north of this UST. This UST stored fuel oil for a boiler house (Building NS-2) built in 1958. No. 5 fuel oil was used until 1991; from 1991 on, the UST stored cleaner-burning No. 2 fuel oil. The AOC 675 area was also used to refuel seaplanes, and petroleum contamination may have resulted from this activity. Actual dates of seaplane operations are unknown, but this activity was discontinued in the mid 1950s.

Former UST NS2A was an unregulated 560 gallon underground waste oil holding tank for an oil/water separator. It was located in a grass covered patch of ground between Buildings NS 2 and NS 3. This tank was closed by removal in April 1996. During removal it was noted that the tank was intact with no holes or pitting. The oil/water separator which was associated with the waste oil UST and is currently identified as NS 2A is located immediately east of the former waste oil UST. The oil/waste separator was left in place and its lines were plugged and capped.

Former UST NS 3-1 was a 280 gallon waste oil holding tank and oil/water separator located just north of Building NS 3. Building NS 3 is a former fuel pumping transfer station located just west of NS 4. The fuel transfer area was diked and sloped towards a storm drain in the east corner. The storm drain was connected to the storm sewer by two sets of valves and piping. The valves directed the storm water runoff directly to the storm sewer during normal operations or through the oil/water separator to the storm sewer in the event of a spill in the fuel transfer area.

AOC 676 is the location of a former incinerator which operated near the current location of Building NS-2. The incinerator was used during the 1940s: it is shown on base maps from 1947 to 1955. No records exist concerning its design, operation, or demolition. The materials burned in the incinerator are unknown but may have included flammable hazardous materials (paints, solvents, and waste oils), as well as paper, wood, and general trash.

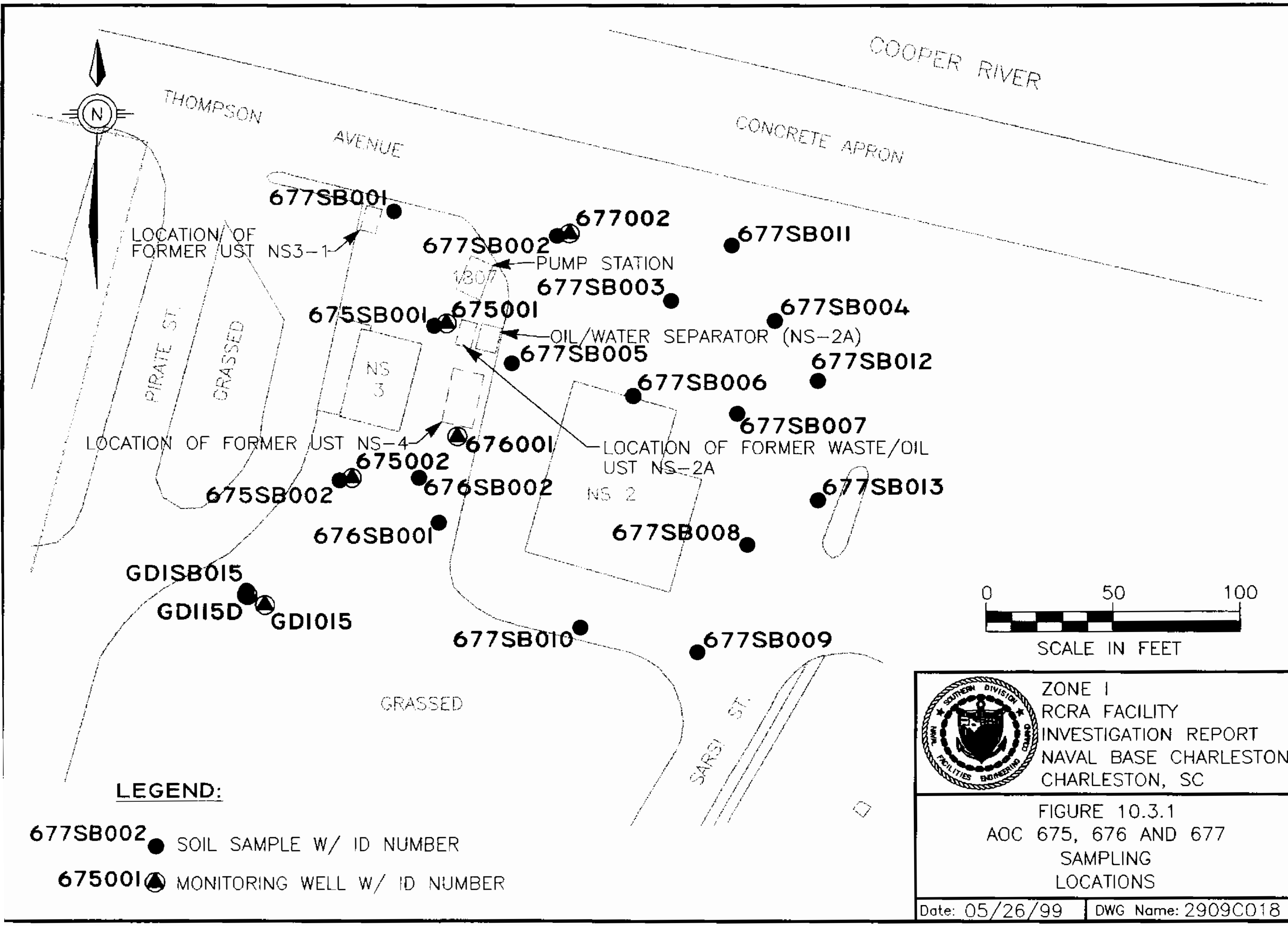
AOC 677 consists of the grounds surrounding Building NS-2, a boiler house. The facility was built in 1958; in 1977, the boilers were replaced with newer ones. There is a documented history of fuel oil spills at this site, ranging in size from 3 to 500 gallons. Fuel for the boilers were stored in the nearby 25,000-gallon UST at Facility NS-4 (AOC 675) as described above. Prior to 1979 the sump pump for the boilers discharged to the base storm sewer system. After 1979, the sump pump discharged to the sanitary sewer system via an oil/water separator. In 1990, the boilers at were connected to the basewide steam system to provide backup power for the central power plant.

Materials of concern at AOCs 675 and 677 include residual fuel, diesel fuel, aviation gasoline, and lead as an additive in the fuel. Materials of concern at AOC 676 include ash potentially high in metals, and petroleum products. Potential receptors include future users involved in invasive and noninvasive activities. The ecology of the Cooper River is also a potential receptor.

To fulfill CSI objectives for AOCs 675 and 676, and RFI objectives for AOC 677, soil, sediment, and groundwater were sampled in accordance with the approved final RFI work plan and Section 3 of this report.

10.3.1 Soil Sampling and Analysis

Soil was sampled in one round at the combined AOCs from the locations shown on Figure 10.3.1. The approved final RFI work plan proposed 13 soil borings, with samples collected from the upper- and lower-intervals. During the first round field investigation, 14 soil borings were advanced. Upper-interval samples were collected at all borings; however, only eight lower-interval samples were collected



ZONE I
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.3.1
AOC 675, 676 AND 677
SAMPLING
LOCATIONS

Date: 05/26/99 | DWG Name: 2909C018

because the water table was encountered at less than 5 feet bgs. All samples were analyzed for VOCs, SVOCs, pesticides/PCBs, cyanide, and metals. Samples from AOC 677 were also analyzed for organotins. One upper-interval sample from AOC 677 (677SB01001) was analyzed for physical parameters. Three samples selected as duplicates were analyzed at DQO Level IV for Appendix IX analytical parameters (except that duplicate sample 677CB01001 was not analyzed for cyanide). In the second round field investigation, three additional soil borings were advanced. Three upper-level interval samples and one lower-level interval sample were collected for dioxins. Table10.3.1 summarizes soil sampling at the combined AOCs.

Grid soil samples GDISB01501 and GDISB01502 were collected in the area of the combined AOCs and analyzed for the standard suite of parameters. Results of these analyses are discussed together with analytical results for the combined AOCs.

Table 10.3.1
AOCs 675/676/677
Soil Sampling Summary

Sampling Round	Sampling Date	Samples Collected	Sample Analyses	Comments
1	02/21/95 02/27/95 02/28/95	Upper - 14 (13)	Standard Suite, Organotins	Organotins were collected on nine upper-interval samples (677SB00201 through 677SB01001) for site characterization.
		Lower - 8 (13)	Standard Suite, Organotins	Six lower-interval samples were not collected due to a water table at less than 5 feet bgs. Organotins were collected on six lower-interval samples (677SB00202, 677SB00302, 677SB00402, 677SB00602, 677SB00702, and 677SB00902) for site characterization.
		Duplicate - 3	Appendix IX	677CB00101/677CB00201/677CB01001*
2	09/07/95	Upper - 1	Physical Parameters	Sample for physical parameters collected at boring location 677SB01001.
3	02/02/99	Upper - 3	Dioxins	Dioxins were collected on 3 upper-interval samples 677SB011, 677SB012, and 677SB013
		Lower - 1	Dioxins	One low-interval sample (677SB011) was collected for dioxins

Notes:
( ) = Parenthesis indicate number of samples proposed in the RFI work plan.
* = 677CB01001 was not analyzed for cyanide.
Standard Suite = VOCs, SVOCs, metals, cyanide, pesticides, and PCBs at DQO Level III.
Appendix IX = Standard Suite, plus hex-chrome, dioxins, herbicides, and OP pesticides at DQO Level IV.
Physical parameters analyses included CEC, chloride, sulfur, ammonia, nitrate/nitrite, phosphorus, TOC and total moisture.

10.3.2 Nature and Extent of Contamination in Soil

Organic compound analytical results for soil are summarized in Table 10.3.2. Inorganic compound analytical results are summarized in Table 10.3.3. Table 10.3.4 summarizes all analytes detected in soil at AOCs 675/676/677. Appendix D contains the complete analytical data report for all samples collected in Zone I.

Volatile Organic Compounds in Soil

Three VOCs were detected in soil samples at the combined AOCs. Acetone, acetonitrile, and toluene were detected in surface and subsurface soil samples at concentrations far below their RBCs and SSLs.

Table 10.3.2
AOCs 675/676/677
Organic Compound Analytical Results for Soil (μg/kg)

Parameter	Sample Interval	Detection Frequency	Detection Range	Mean	RBC (upper) SSL (lower)	Number of Samples Exceeding RBC or SSL
Volatile Organic Compounds						
Acetone	Upper	3/14	32.0 - 72.0	52.0	780,000	0
	Lower	4/8	17.0 - 200	76.8	8,000	0
Acetonitrile	Upper	1/14	100	100	47,000	0
	Lower	2/8	81.0 - 150	116	440	0
Toluene	Upper	10/14	1.0 - 6.0	2.7	1,600,000	0
	Lower	5/8	2.0 - 23.0	10.8	6,000	0
Semivolatile Organic Compounds						
BEQs	Upper	3/14	0.047 - 478	161	87	1
	Lower	3/8	17.5 - 252	118	1600	0
Benzo(a)anthracene	Upper	2/14	41.0 - 720	381	870	0
	Lower	3/8	53.0 - 480	228	800	0
Benzo(a)pyrene	Upper	1/14	330	330	87	1
	Lower	2/8	51.0 - 180	116	4,000	0
Benzo(b)fluoranthene	Upper	1/14	670	670	870	0
	Lower	3/8	110 - 220	163	2,500	0
Benzo(k)fluoranthene	Upper	1/14	840	840	8,700	0
	Lower	3/8	110 - 190	147	25,000	0
Chrysene	Upper	3/14	44.0 - 640	244	87,000	0
	Lower	3/8	62.0 - 420	204	80,000	0

Table 10.3.2
AOCs 675/676/677
Organic Compound Analytical Results for Soil (μg/kg)

Parameter	Sample Interval	Detection Frequency	Detection Range	Mean	RBC (upper) SSL (lower)	Number of Samples Exceeding RBC or SSL
Dibenzofuran	Upper	0/14	ND	ND	31,000	0
	Lower	1/8	1,800	1,800	6,800	0
1-Methylnaphthalene	Upper	1/14	210	210	310,000	0
	Lower	1/8	1,700	1,700	72,000	0
2-Methylnaphthalene	Upper	1/14	200	200	310,000	0
	Lower	1/8	1,900	1,900	230,000	0
Acenaphthene	Upper	2/14	99.0 - 110	105	470,000	0
	Lower	1/8	2,300	2,300	290,000	0
Anthracene	Upper	1/14	110	110	2,300,000	0
	Lower	2/8	72.0 - 930	501	5,900,000	0
Di-n-butylphthalate	Upper	1/14	35.0	35.0	780,000	0
	Lower	0/8	ND	ND	2,300,000	0
Fluoranthene	Upper	3/14	41.0 - 1,000	364	310,000	0
	Lower	7/8	34.0 - 2,800	491	2,100,000	0
Fluorene	Upper	0/14	ND	ND	310,000	0
	Lower	1/8	2,200	2,200	280,000	0
Naphthalene	Upper	2/14	52.0 - 2,200	1,130	310,000	0
	Lower	1/8	5,900	5,900	42,000	0
Phenanthrene	Upper	1/14	55.0	55.0	230,000	0
	Lower	2/8	110 - 6,200	3,160	660,000	0
Pyrene	Upper	3/14	42.0 - 810	304	230,000	0
	Lower	6/8	95.0 - 1,900	409	2,100,000	0
bis(2-Ethylhexyl)phthalate	Upper	1/14	84.0	84.0	46,000	0
	Lower	0/8	ND	ND	1,800,000	0
Pesticides/PCBs						
4,4'-DDD	Upper	5/14	2.0 - 34.0	16.2	2,700	0
	Lower	5/8	7.6 - 500	130	8,000	0
4,4'-DDE	Upper	3/14	7.3 - 38.0	18.2	1,900	0
	Lower	5/8	19.0 - 240	65.4	27,000	0
4,4'-DDT	Upper	2/14	4.0 - 24.0	14.0	1,900	0
	Lower	2/8	22.0 - 71.0	46.5	16,000	0
Chlordane	Upper	2/14	6.0 - 7.6	6.8	1,800	0
	Lower	0/8	ND	ND	5,000	0
Endrin	Upper	1/14	2.8	2.8	2,300	0
	Lower	0/8	ND	ND	500	0
Endrin aldehyde	Upper	3/14	1.4 - 1.6	1.5	2,300	0
	Lower	0/8	ND	ND	340	0
beta-BHC	Upper	1/14	1.3	1.3	350	0
	Lower	0/8	ND	ND	1.3	0

Table 10.3.2
AOCs 675/676/677
Organic Compound Analytical Results for Soil (μg/kg)

Parameter	Sample Interval	Detection Frequency	Detection Range	Mean	RBC (upper) SSL (lower)	Number of Samples Exceeding RBC or SSL
gamma-BHC (Lindane)	Upper	1/14	1.2	1.2	490	0
	Lower	0/8	ND	ND	4.5	0
delta-BHC	Upper	1/14	1.1	1.1	350	0
	Lower	0/8	ND	ND	1.8	0
Heptachlor epoxide	Upper	2/14	1.4 - 3.0	2.2	70	0
	Lower	0/8	ND	ND	330	0
Aroclor-1260	Upper	1/14	61.0	61.0	320	0
	Lower	0/8	ND	ND	1,000	0
Dioxin Compounds						
TEQs	Upper	6/6	1.16E-04 - 2.08E-03	1.07E-03	0.0043	0
	Lower	1/1	8.83E-05	8.83E-05	1.6	0
123678-HxCDD	Upper	1/6	1.09E-03	1.09E-03	0.043	0
	Lower	0/1	ND	ND	4.1	0
123789-HxCDD	Upper	2/6	6.53E-04 - 9.2E-04	7.86E-04	0.043	0
	Lower	0/1	ND	ND	4.1	0
1234678-HpCDD	Upper	6/6	4.05E-03 - 9.56E-02	3.55E-02	0.43	0
	Lower	1/1	1.88E-03	1.88E-03	108	0
OCDD	Upper	6/6	0.474 - 0.926	0.433	4.3	0
	Lower	1/1	6.59E-02	6.59E-02	1,080	0
123478-HxCDF	Upper	1/6	2.06E-03	2.06E-03	0.043	0
	Lower	0/1	ND	ND	216	0
123678-HxCDF	Upper	1/6	8.4E-04	8.4E-04	0.043	0
	Lower	0/1	ND	ND	216	0
234678-HxCDF	Upper	1/6	8.6E-04	8.6E-04	0.043	0
	Lower	0/1	ND	ND	216	0
1234678-HpCDF	Upper	6/6	5.48E-04 - 1.66E-02	6.49E-03	0.43	0
	Lower	1/1	3.2E-04	3.2E-04	54	0
OCDF	Upper	5/6	7.21E-04 - 2.15E-02	10.45E-03	4.3	0
	Lower	0/1	3.28E-04	3.28E-04	540	0
Organotin Compounds						
Tetrabutyltin	Upper	1/9	25.28	25.28	2,300	0
	Lower	0/6	ND	ND	NL	0

Notes:
NA = Not Applicable/Not Available/Not Analyzed
ND = Not Detected/Not Determined
NL = Not Listed
μg/kg = micrograms per kilogram
See Table 5.5 for organic compound screening concentrations and their sources.

Table 10.3.3
AOCs 675/676/677
Inorganic Compound Analytical Results for Soil (mg/kg)

Parameter	Sample Interval	Detection Frequency	Detection Range	Mean	Background Concentration	RBC (upper) SSL (lower)	Number of Samples Exceeding: RBC & Background (upper) or SSL & Background (lower)
Aluminum (Al)	Upper	14/14	4,310 - 11,800	7,720	27,400	7,800	0
	Lower	8/8	7,110 - 24,900	13,700	18,900	560,000	0
Antimony (Sb)	Upper	2/14	6.0 - 6.6	6.3	ND	3.1	2
	Lower	3/8	5.3 - 9.2	7.3	ND	2.7	3
Arsenic (As)	Upper	5/14	3.1 - 5.4	4.2	21.6	0.43	0
	Lower	8/8	4.7 - 14.4	9.2	6.45	15	0
Barium (Ba)	Upper	14/14	6.0 - 25.7	17.4	54.2	550	0
	Lower	8/8	18.4 - 33.0	22.3	36.0	820	0
Beryllium (Be)	Upper	5/14	0.21 - 0.98	0.54	0.95	16	0
	Lower	7/8	0.35 - 1.1	0.71	0.67	32	0
Cadmium (Cd)	Upper	2/14	0.53 - 0.72	0.63	0.61	7.8	0
	Lower	2/8	0.18 - 1.2	0.69	0.54	4.0	0
Calcium (Ca)	Upper	14/14	4,840 - 71,400	28,700	NL	NL	NA
	Lower	8/8	9,250 - 235,000	65,100	NL	NL	NA
Chromium (Total) (Cr)	Upper	14/14	9.7 - 70.5	30.0	34.5	39	2
	Lower	8/8	20.7 - 46.1	32.5	51.3	19	0
Chromium (Hexavalent)	Upper	1/3	0.426	0.426	ND	39	0
	Lower	0/0	NA	NA	ND	19	0
Cobalt (Co)	Upper	13/14	1.4 - 4.4	2.3	5.80	470	0
	Lower	8/8	2.0 - 7.4	4.3	3.48	990	0
Copper (Cu)	Upper	14/14	1.6 - 26.6	9.3	240	310	0
	Lower	8/8	7.3 - 278	43.0	11.5	5,600	0
Iron (Fe)	Upper	14/14	2,670 - 8,870	5,210	NL	NL	NA
	Lower	8/8	6,970 - 24,600	12,300	NL	NL	NA

Table 10.3.3
AOCs 675/676/677
Inorganic Compound Analytical Results for Soil (mg/kg)

Parameter	Sample Interval	Detection Frequency	Detection Range	Mean	Background Concentration	RBC (upper) SSL (lower)	Number of Samples Exceeding: RBC & Background (upper) or SSL & Background (lower)
Lead (Pb)	Upper	14/14	3.6 - 42.4	15.0	203	400	0
	Lower	8/8	6.5 - 20.2	13.6	12.3	400	0
Magnesium (Mn)	Upper	14/14	507 - 2,400	1,260	NL	NL	NA
	Lower	8/8	2,160 - 6,030	3,370	NL	NL	NA
Manganese (Mn)	Upper	14/14	18.8 - 1,420	147	419	160	1
	Lower	8/8	73.0 - 188	113	118	480	0
Mercury (Hg)	Upper	1/14	0.11	0.11	0.47	2.3	0
	Lower	1/8	0.20	0.20	ND	1.0	0
Nickel (Ni)	Upper	14/14	2.7 - 20.9	7.45	23.9	160	0
	Lower	8/8	6.9 - 21.1	10.9	15.7	65	0
Potassium (K)	Upper	4/14	226 - 974	643	NL	NL	NA
	Lower	8/8	952 - 2,620	1,480	NL	NL	NA
Selenium (Se)	Upper	4/14	0.64 - 0.97	0.78	1.49	39	0
	Lower	6/8	0.52 - 2.1	1.16	1.77	2.6	0
Sodium (Na)	Upper	13/14	101 - 1,200	410	NL	NL	NA
	Lower	8/8	579 - 2,010	1,020	NL	NL	NA
Thallium (Tl)	Upper	4/14	0.31 - 0.42	0.36	ND	0.55	0
	Lower	4/8	0.34 - 0.57	0.47	ND	0.36	3
Tin (Sn)	Upper	3/14	1.0 - 2.4	1.7	7.50	4,700	0
	Lower	3/8	10.6 - 11.2	10.9	ND	5,500	0
Vanadium (V)	Upper	14/14	6.7 - 176	38.3	113	55	2
	Lower	8/8	18.0 - 57.1	30.5	38.1	3,000	0

Table 10.3.3
AOCs 675/676/677
Inorganic Compound Analytical Results for Soil (mg/kg)

Parameter	Sample Interval	Detection Frequency	Detection Range	Mean	Background Concentration	RBC (upper) SSL (lower)	Number of Samples Exceeding: RBC & Background (upper) or SSL & Background (lower)
Zinc (Zn)	Upper	14/14	6.2 - 130	34.8	206	2,300	0
	Lower	8/8	29.2 - 76.7	44.4	36.2	6,200	0

Notes:
NA = Not Applicable/Not Available
ND = Not Detected/Not Determined
NL = Not Listed
mg/kg = milligrams per kilogram
See Table 5.6 for inorganic compound screening concentrations and their sources.

Table 10.3.4
AOCs 675/676/677
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Volatile Organic Compounds ($\mu g/kg$)							
Acetone	676SB001	ND	780000	NA	17	8000	NA
	677SB002	32			26		
	677SB004	ND			64		
	677SB006	72			200		
	677SB010	52			NT		
Acetonitrile (methyl cyanide)	677SB004	ND	47000	NA	81	440	NA
	677SB006	100			150		
2-Butanone (MEK)	677SB004	ND	4700000	NA	46	3900	NA
	677SB009	ND			40		
Propionitrile (ethyl cyanide)	677SB004	ND	47000	NA	780	440	NA
Toluene	675SB001	3	1600000	NA	NT	6000	NA
	676SB001	1			19		
	676SB002	6			ND		
	677SB001	1			NT		
	677SB002	5			23		
	677SB003	2			ND		
	677SB004	ND			2		
	677SB006	3			6		

Table 10.3.4
AOCs 675/676/677
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Toluene (Continued)	677SB008	2			NT		
	677SB009	2			4		
	677SB010	2			NT		
Semivolatile Organic Compounds (μg/kg)							
Acenaphthene	677SB006	99	470000	NA	ND	290000	NA
	677SB009	ND			2300		
	677SB010	110			NT		
Anthracene	677SB004	ND	2300000	NA	72	5900000	NA
	677SB006	110			ND		
	677SB009	ND			930		
Benzo(a)pyrene Equivalents (BEQs)	676SB001	4.14	87	NA	17.5	1600	NA
	677SB004	ND			84.0		
	677SB006	478			ND		
	677SB009	ND			2.52		
	677SB010	0.047			ND		
Benzo(a)anthracene	676SB001	41	870	NA	53	800	NA
	677SB004	ND			150		
	677SB006	720			ND		
	677SB009	ND			480		

Table 10.3.4
AOCs 675/676/677
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Benzo(a)pyrene	677SB004	ND	87	NA	51	4000	NA
	677SB006	330			ND		
	677SB009	ND			180		
Benzo(b)fluoranthene	676SB001	ND	870	NA	110	2500	NA
	677SB004	ND			160		
	677SB006	670			ND		
	677SB009	ND			220		
Benzo(k)fluoranthene	676SB001	ND	8700	NA	110	25000	NA
	677SB004	ND			190		
	677SB006	840			ND		
	677SB009	ND			140		
Chrysene	676SB001	44	87000	NA	62	80000	NA
	677SB004	ND			130		
	677SB006	640			ND		
	677SB009	ND			420		
	677CB010	47			NT		
Dibenzofuran	677SB009	ND	31000	NA	1800	6800*	NA
Di-n-butylphthalate	677SB005	35	780000	NA	NT	2300000	NA
bis(2-Ethylhexyl)phthalate (BEHP)	677SB007	84	46000	NA	ND	1800000	NA

Table 10.3.4
AOCs 675/676/677
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Fluoranthene	676SB001	51	310000	NA	150	2100000	NA
	676SB002	ND			34		
	677SB003	ND			64		
	677SB004	ND			260		
	677SB006	1000			68		
	677SB007	ND			58		
	677SB009	ND			2800		
	677SB010	41			NT		
Fluorene	677SB009	ND	310000	NA	2200	280000	NA
1-Methylnaphthalene	677SB009	ND	310000	NA	1700	72000	NA
	677SB010	210			NT		
2-Methylnaphthalene	677SB009	ND	310000	NA	1900	230000	NA
	677SB010	200			NT		
Naphthalene	677SB006	52	310000	NA	ND	42000	NA
	677SB009	ND			5900		
	677SB010	2200			NT		
Phenanthrene	677SB004	ND	230000	NA	110	660000	NA
	677SB006	55			ND		
	677SB009	ND			6200		

Table 10.3.4
AOCs 675/676/677
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Pyrene	676SB001	42	230000	NA	130	2100000	NA
	676SB002	ND			35		
	677SB003	ND			59		
	677SB004	ND			240		
	677SB006	810			ND		
	677SB007	ND			56		
	677SB009	ND			1900		
	677SB010	61			NT		
Pesticides/PCBs (μg/kg)							
Aroclor-1260	675SB001	61	320	NA	NT	1000	NA
beta-BHC (beta-HCH)	675SB002	1.3	350	NA	NT	1.3	NA
delta-BHC (delta-HCH)	676SB002	1.1	350	NA	ND	1.8	NA
gamma-BHC (Lindane)	675SB001	1.2	490	NA	NT	4.5	NA
Chlordane	675SB002	7.6	1800	NA	NT	5000	
	676SB001	6.0			ND		
4,4'-DDD	675SB002	2	2700	NA	NT	8000	NA
	676SB001	ND			40		
	676SB002	ND			89		
	677SB002	6.7			ND		
	677SB003	ND			7.6		
	677SB004	ND			500		
	677SB006	34			ND		

Table 10.3.4
AOCs 675/676/677
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
4,4'-DDD (Continued)	677SB007	ND			14		
	677SB009	7.5			ND		
	677SB010	31			NT		
4,4'-DDE	676SB001	ND	1900	NA	46	27000	NA
	677SB002	ND			13		
	677SB003	ND			13		
	677SB004	ND			240		
	677SB006	9.2			ND		
	677SB007	ND			15		
	677SB009	7.3			ND		
	677SB010	38			NT		
4,4'-DDT	676SB002	ND	1900	NA	71	16000	NA
	677SB004	ND			22		
	677SB006	4			ND		
	677SB007	24			ND		
Endrin	677SB009	2.8	2300	NA	ND	500	NA
Endrin aldehyde	675SB002	1.4	2300	NA	NT	340	NA
	676SB001	1.4			ND		
	677SB001	1.6			NT		

Table 10.3.4
AOCs 675/676/677
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Heptachlor epoxide	675SB002	3	70	NA	NT	330	NA
	676SB001	1.4			ND		
Organotin (μg/kg)							
Tetrabutyltin	677SB006	25.28	2300	NA	NT	NA	NA
Dioxin Compounds (ng/kg)							
2,3,7,8-TCDD equivalents (TEQs)	676SB001	1.51	4.3	NA	NT	1600	NA
	676SB002	2.02			NT		
	677SB010	1.12			NT		
	677SB011	0.313			0.09		
	677SB012	0.116			NT		
	677SB013	0.741			NT		
123678-HxCDD	676SB001	1.086	43	NA	NT	4100	NA
123789-HxCDD	676SB001	0.92	43	NA	NT	4100	NA
	677SB013	0.653			NT		
1234678-HpCDD	676SB001	44.778	430	NA	NT	108000	NA
	676SB002	95.58			NT		
	677SB010	45.92			NT		
	677SB011	4.05			1.89		
	677SB012	4.721			NT		
	677SB013	18.199			NT		

Table 10.3.4
AOCs 675/676/677
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
OCDD	676SB001	399.06	4300	NA	NT	1080000	NA
	676SB002	926.32			NT		
	677SB010	474.47			NT		
	677SB011	265.96			65.96		
	677SB012	62.68			NT		
	677SB013	472.67			NT		
123478-HxCDF	676SB001	2.063	43	NA	NT	216000	NA
123678-HxCDF	676SB001	0.837	43	NA	NT	216000	NA
234678-HxCDF	676SB001	0.863	43	NA	NT	216000	NA
1234678-HpCDF	676SB001	7.609	430	NA	NT	54000	NA
	676SB002	11.432			NT		
	677SB010	16.634			NT		
	677SB011	0.594			0.32		
	677SB012	0.548			NT		
	677SB013	2.143			NT		
OCDF	676SB001	10.7	4300	NA	NT	540000	NA
	676SB002	21.5			NT		
	677SB010	17.8			NT		
	677SB011	0.721			0.33		
	677SB012	1.597			NT		

Table 10.3.4
AOCs 675/676/677
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Inorganics (mg/kg)							
Aluminum (Al)	675SB001	11800	7800	27400	NT	560000	18900
	675SB002	8480			NT		
	676SB001	10300			13700		
	676SB002	9070			17300		
	677SB001	9860			NT		
	677SB002	7480			7780		
	677SB003	4310			15900		
	677SB004	5620			7110		
	677SB005	7120			NT		
	677SB006	8140			24900		
	677SB007	6210			9720		
	677SB008	7870			NT		
	677SB009	6500			13500		
	677SB010	6080			NT		
Antimony (Sb)	677SB003	ND	3.1	ND	9.2	2.7	ND
	677SB006	6.6			7.5		
	677SB009	ND			5.3		
	677SB010	6			NT		

Table 10.3.4
AOCs 675/676/677
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Arsenic (As)	676SB001	4.8	0.43	21.6	7.7	15	6.45
	676SB002	4			14.4		
	677SB002	ND			10.9		
	677SB003	ND			10.4		
	677SB004	ND			5.3		
	677SB005	3.7			NT		
	677SB006	5.4			13.7		
	677SB007	ND			4.7		
	677SB009	ND			6.4		
	677SB010	3.1			NT		
Barium (Ba)	675SB001	25.7	550	54.2	NT	820	36
	675SB002	16.3			NT		
	676SB001	25.4			19.8		
	676SB002	15.95			21.2		
	677SB001	19.9			NT		
	677SB002	12.9			19.5		
	677SB003	6.1			19.8		
	677SB004	6			19		
	677SB005	17.1			NT		
	677SB006	23			33		

Table 10.3.4
AOCs 675/676/677
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Barium (Ba) (Continued)	677SB007	22.6			18.4		
	677SB008	16.6			NT		
	677SB009	17.7			27.5		
	677SB010	20.2			NT		
Beryllium (Be)	675SB001	0.52	16	0.95	NT	32	0.67
	676SB001	0.98			0.65		
	676SB002	0.62			0.89		
	677SB001	0.37			NT		
	677SB002	ND			0.53		
	677SB003	ND			0.85		
	677SB004	ND			0.35		
	677SB005	0.21			NT		
	677SB006	ND			1.1		
	677SB009	ND			0.62		
Cadmium (Cd)	676SB002	0.53	7.8	0.61	ND	4	0.54
	677SB002	ND			1.2		
	677SB004	ND			0.18		
	677SB006	0.72			ND		

Table 10.3.4
AOCs 675/676/677
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Chromium (Cr) (total)	675SB001	70.5	39	34.5	NT	19	51.3
	675SB002	22.4			NT		
	676SB001	24.3			28.5		
	676SB002	18.35			32.2		
	677SB001	31.2			NT		
	677SB002	63.7			46.1		
	677SB003	22.4			32.3		
	677SB004	9.7			20.7		
	677SB005	21.8			NT		
	677SB006	22.5			42.5		
	677SB007	35.7			32		
	677SB008	33.5			NT		
	677SB009	19.3			25.4		
	677SB010	24.6			NT		
Chromium (Cr6) (hexavalent)	676CB001	0.01	39	ND	NT	19	ND
	676CB002	0.01			NT		
	677CB010	0.01			NT		

Table 10.3.4
AOCs 675/676/677
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Cobalt (Co)	675SB001	4.4	470	5.8	NT	990	3.48
	675SB002	1.5			NT		
	676SB001	1.75			3.9		
	676SB002	1.85			5.4		
	677SB001	2.2			NT		
	677SB002	ND			2.5		
	677SB003	1.9			5.4		
	677SB004	1.4			2		
	677SB005	1.4			NT		
	677SB006	2.5			7.4		
	677SB007	3.5			3.8		
	677SB008	3.5			NT		
	677SB009	1.8			3.6		
	677SB010	2.35			NT		
Copper (Cu)	675SB001	26.6	310	240	NT	5600	11.5
	675SB002	26.5			NT		
	676SB001	17.05			9.2		
	676SB002	10.45			8.4		
	677SB001	14.5			NT		
	677SB002	3.8			278		

Table 10.3.4
AOCs 675/676/677
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Copper (Cu) (Continued)	677SB003	1.7			9.9		
	677SB004	1.6			10		
	677SB005	6.7			NT		
	677SB006	6			14		
	677SB007	2			7.3		
	677SB008	5.6			NT		
	677SB009	3			7.5		
	677SB010	4.5			NT		
Lead (Pb)	675SB001	6.4	400	203	NT	400	12.3
	675SB002	37.1			NT		
	676SB001	42.4			10.9		
	676SB002	21.65			9.7		
	677SB001	18.2			NT		
	677SB002	6.3			19.9		
	677SB003	6.4			9.7		
	677SB004	3.6			14.6		
	677SB005	9.1			NT		
	677SB006	18.4			20.2		
	677SB007	6.4			6.5		
	677SB008	10.3			NT		
	677SB009	15.9			17.3		
	677SB010	7.3			NT		

Table 10.3.4
AOCs 675/676/677
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Manganese (Mn)	675SB001	1420	160	419	NT	480	118
	675SB002	40.3			NT		
	676SB001	58.1			106		
	676SB002	31.2			124		
	677SB001	61.2			NT		
	677SB002	28.5			75.9		
	677SB003	50.6			167		
	677SB004	18.8			73		
	677SB005	75.7			NT		
	677SB006	58.2			188		
	677SB007	88.8			82.1		
	677SB008	34.1			NT		
	677SB009	34.3			85.1		
	677SB010	57.2			NT		
Mercury (Hg)	676SB001	0.11	2.3	0.47	ND	1	ND
	677SB006	ND			0.2		
Nickel (Ni)	675SB001	11.9	160	23.9	NT	65	15.7
	675SB002	10.6			NT		
	676SB001	20.85			10.6		
	676SB002	13.5			10.7		

Table 10.3.4
AOCs 675/676/677
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Nickel (Ni) (Continued)	677SB001	8.5			NT		
	677SB002	2.8			21.1		
	677SB003	2.9			10.8		
	677SB004	2.7			8.4		
	677SB005	6.6			NT		
	677SB006	7.3			9.1		
	677SB007	3.6			9.4		
	677SB008	4			NT		
	677SB009	2.9			6.9		
	677SB010	6.6			NT		
Selenium (Se)	675SB002	0.68	39	1.49	NT	2.6	1.77
	676SB001	0.64			ND		
	676SB002	ND			0.98		
	677SB002	ND			2.1		
	677SB003	ND			0.78		
	677SB004	ND			1.1		
	677SB006	0.85			1.45		
	677SB007	ND			0.52		
	677SB010	0.97			NT		

Table 10.3.4
AOCs 675/676/677
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Thallium (Tl)	676SB002	0.42	0.55	ND	0.57	0.36	ND
	677SB003	ND			0.52		
	677SB006	ND			0.45		
	677SB007	ND			0.34		
	677SB008	0.31			NT		
	677SB009	0.36			ND		
	677SB010	0.33			NT		
Tin (Sn)	675SB002	2.4	4700	7.5	ND	5500	ND
	676SB001	1.8			ND		
	677SB002	ND			11		
	677SB003	ND			11.2		
	677SB006	ND			10.6		
	677SB007	1			ND		
Vanadium (V)	675SB001	47	55	113	NT	3000	38.1
	675SB002	37.1			NT		
	676SB001	176			28.4		
	676SB002	125.5			36.3		
	677SB001	34.9			NT		

Table 10.3.4
AOCs 675/676/677
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Vanadium (V) (Continued)	677SB002	10.9			27.6		
	677SB003	6.7			32.9		
	677SB004	7.5			18		
	677SB005	19.9			NT		
	677SB006	17.7			57.1		
	677SB007	9.5			20.4		
	677SB008	13.7			NT		
	677SB009	13			23.4		
	677SB010	17			NT		
Zinc (Zn)	675SB001	51.9	2300	206	NT	6200	36.2
	675SB002	66.7			NT		
	676SB001	81.55			54.7		
	676SB002	32.05			36.6		
	677SB001	130			NT		
	677SB002	8.7			76.7		
	677SB003	6.7			38.2		
	677SB004	6.2			39.5		
	677SB005	23.1			NT		

Table 10.3.4
AOCs 675/676/677
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Zinc (Zn) (Continued)	677SB006	26.5			46.3		
	677SB007	7.2			29.2		
	677SB008	16.8			NT		
	677SB009	7.8			33.7		
	677SB010	21.25			NT		

Notes:

a = Background value for non clay samples
* = Residential RBCs (THQ=0.1) were used as a reference concentration for upper-interval samples. Generic soil-to groundwater SSLs (DAF=10) from *Soil Screening Guidance: Technical Background Document* (USEPA, 1996b) were used as a reference concentration for lower-interval samples

Bold concentrations exceed the RBCs, SSL, and the zone background
All background values for Zone I are based on twice the means of the grid sample concentrations.

DAF = Dilution attenuation factor
NA = Not applicable/not available
ND = Not detected
NT = Not taken
RBC = Risk-based concentration
SSL = Soil screening level
THQ = Target hazard quotient
μg/kg = Micrograms per kilogram
mg/kg = milligrams per kilogtam

The VOCs acetone and toluene were also detected at grid soil boring GDISB015. Acetone was detected at 43 μg/kg and toluene was detected at 3 μg/kg in surface soil sample GDISB01501. Acetone and toluene were also detected in subsurface soil sample GDISB01502 at concentrations of 48 μg/kg and 21 μg/kg, respectively. These detections were far below the corresponding RBCs or SSLs.

Semivolatile Organic Compounds in Soil

Fifteen SVOCs were detected in surface soil samples at the combined AOCs. Benzo(a)pyrene exceeded its RBC in sample 677SB00601 (330 μg/kg). All other surface SVOC detections were far below their respective RBCs. Fifteen SVOCs were also detected in the subsurface samples, all at levels far below their SSLs.

No SVOCs were detected in surface soil at grid soil boring GDISB015, but nine SVOCs were detected in subsurface grid-based sample GDISB01502: anthracene (160 μg/kg), benzo(a)anthracene (130 μg/kg), benzo(a)pyrene (52 μg/kg), benzo(b)fluoranthene (120μg/kg), benzo(k)fluoranthene (130 μg/kg), chrysene (140 μg/kg), di-n-butylphthalate (82 μg/kg), fluoranthene (650 μg/kg), and pyrene (450 μg/kg). All SVOC concentrations were far below their SSLs.

In accordance with recent cPAH guidance and Section 7 of this report, BEQs were calculated for cPAHs at the combined AOCs. The calculated BEQ of 478 μg/kg for surface soil sample 677SB00601 exceeded the benzo(a)pyrene residential soil RBC of 87 μg/kg. Calculated BEQs for subsurface soil samples ranged from 17.5 μg/kg to 252 μg/kg, which is below the SSL of 1600 μg/kg.

Pesticides and PCBs in Soil

Ten pesticides were detected in surface soil at the combined AOCs. Three pesticides were detected in the subsurface soil. No surface or subsurface soil pesticide concentration exceeded its RBC or SSL. One PCB, Aroclor-1260, was detected in surface soil at a concentration far below its RBC. No PCBs were detected in the subsurface soil.

One pesticide, endrin aldehyde (2.6 μg/kg), was detected in grid-based surface soil sample GDISB01501. This concentration is far below the RBC. Four pesticides were detected in grid-based subsurface soil sample GDISB01502: endosulfan sulfate (2.9 μg/kg), dieldrin (8.3 μg/kg), 4,4'-DDD (76 μg/kg), and 4,4'-DDE (32 μg/kg). Of these only dieldrin exceeded its SSL.

Other Organic Compounds in Soil

Dioxin compounds were detected in all six of the surface soil samples collected for dioxins. In accordance with recent dioxin guidance and Section 7 of this report, TEQs were calculated. The resulting TEQ range of 1.16E-04 μg/kg to 2.08E-03 μg/kg is below the RBC of 4.3E-03 μg/kg. Dioxin compounds were detected in the subsurface soil sample with a TEQ of 8.83E-05 which is below the SSL value.

The organotin tetrabutylin was detected in surface soil at a concentration far below its RBC.

Inorganics in Soil

Twenty-three metals and hex-chrome were detected in surface soil at the combined AOCs. Concentrations of four metals exceeded their respective RBCs and surface soil background concentrations: antimony [677SB00601 (6.6 mg/kg) and 677SB01001 (6.0 mg/kg)]; total chromium [675SB00101 (70.5 mg/kg), 677SB00201 (63.7 mg/kg)]; manganese [675SB00101 (1,420 mg/kg)]; and vanadium [676SB00101 (176 mg/kg) and 676SB00201 (125.5 mg/kg)].

Twenty-three metals were detected in subsurface soil samples at the combined AOCs. Concentrations of two subsurface metals exceeded their respective RBCs and subsurface soil background concentrations: antimony [677SB00302 (9.2 mg/kg), 677SB00602 (7.5 mg/kg), and 677SB00902 (5.3 mg/kg)]; and thallium [676SB00202 (0.57 mg/kg), 677SB00302 (0.52 mg/kg), and 677SB00602 (0.45 mg/kg)].

Sixteen metals were detected in grid-based surface soil sample GDISB01501. Eighteen metals were detected in grid-based subsurface soil sample GDISB00802. No surface or subsurface metal concentration at these grid-based locations exceeded its RBC or SSL.

The original AOCs 675/676/677 RFI, submitted in January 1996, has been updated to include results from more recent sampling efforts. This document (revised and submitted in March 1999) represents "Revision 0" of the original January 1996 RFI.

No changes to extent of contamination definition were identified through the additional soil sample collection and analysis; therefore no changes to the January 1996 version of the AOCs 675/676/677 RFI Report Fate and Transport, Human Health Risk Assessment, and Conclusion sections or the Zone I Ecological Risk Assessment section were made.

10.3.3 Groundwater Sampling and Analysis

The approved final RFI work plan proposed five shallow monitoring wells associated with the combined AOCs. Four monitoring wells were installed and sampled. Subsurface objects and boulders prevented installation of the fifth well. Groundwater was sampled in four rounds at AOCs 675/676/677, as summarized in Table 10.3.5. Monitoring well locations are shown on Figure 10.3.1.

Table 10.3.5
AOCs 675/676/677
Groundwater Sampling Summary

Sampling Round	Sampling Date	Wells Sampled	Sample Analyses	Comments
1	06/01/95	675001	Standard Suite, organotins, chloride, TDS, sulfate	677002 also sampled for herbicides, dioxin, hex-chrome, and OP pesticides
		675002		
	06/05/95	676001		
	06/06/95	677002		
2	01/15/96	675001	Metals, cyanide, pesticides, PCBs, SVOCs	
		675002	Metals, cyanide, pesticides, PCBs, SVOCs, TPH-DRO, TPH-GRO	
		676001	Metals, cyanide, pesticides, PCBs	
		677002	Metals, cyanide, pesticides, PCBs, dioxin	
3	06/03/96	675001	Metals, cyanide, pesticides, PCBs, SVOCs	
		675002	Metals, cyanide, pesticides, PCBs, SVOCs, TPH-DRO, TPH-GRO	
	06/04/96	676001	Metals, cyanide, pesticides, PCBs	
	06/06/96	677002	Metals, cyanide, pesticides, PCBs, dioxin	
4	09/13/96	675001	Metals, cyanide, pesticides, PCBs, SVOCs, TPH-DRO, TPH-GRO	
		675002	Metals, cyanide, pesticides, PCBs, SVOCs, TPH-DRO, TPH-GRO	
	09/12/96	676002	Metals, cyanide, pesticides, PCBs	
	09/10/96	677002	Metals, cyanide, pesticides, PCBs, dioxin, herbicides, chloride, sulfate, TDS	

Note:
Standard Suite = VOCs, SVOCs, metals, cyanide, pesticides, and PCBs at DQO Level III.

In the first round, the wells were sampled and analyzed for VOCs, SVOCs, metals, cyanide, pesticides, PCBs, organotins, chloride, sulfate, and TDS at DQO Level III. To further characterize the groundwater dioxins, herbicides, OP pesticides, and hexavalent chromium analyses were added to sample 677GW00201. All samples from rounds two, three, and four were analyzed for cyanides, metals, pesticides, and PCBs. Table 10.3.5 shows the selected samples analyzed for SVOCs, TPH-DRO/GRO, dioxins, chloride, sulfate, VOCs, and TDS.

Groundwater samples were also collected from a shallow/deep grid monitoring well pair (GDI015/GDI15D) located near AOCs 675/676/677. Both of these wells were sampled during all four sampling events and the samples analyzed for the standard suite of parameters, plus chloride, sulfate, and TDS. Results of these analyses are presented in Appendix D and are discussed below together with groundwater analytical results for the combined AOCs.

10.3.4 Nature and Extent of Contamination in Groundwater

Table 10.3.6 summarizes groundwater organic analytical results for combined AOCs. Table 10.3.7 summarizes groundwater inorganic analytical results. Table 10.3.8 summarizes all analytes detected in shallow groundwater at AOCs 675/676/677. Appendix D contains complete analytical data for all samples collected in Zone I.

Volatile Organic Compounds in Groundwater

One VOC, carbon disulfide, was detected during the first sampling round at well 676001 (1.0 μg/L). No other groundwater VOCs were detected during any of the sampling rounds.

No VOCs were detected in groundwater samples from grid-based wells GDI015 and GDI15D.

Semivolatile Organic Compounds in Groundwater

As many as eleven SVOCs were detected in groundwater during the four sampling rounds. Dibenzofuran slightly exceeded its tap-water RBC during the second and third sampling rounds at well 675002 (3 μg/L and 4 μg/L, respectively). Dimethoate exceeded its tap-water RBC at well 675002 (2 μg/L) during the first sampling round. All other groundwater SVOC concentrations were far below their respective tap-water RBCs.

Table 10.3.6
AOCs 675/676/677
Organic Compound Analysis Results for Groundwater (μg/L)

Parameter	Sample Round	Detection Frequency	Detection Range	Mean	Tap-water RBC/MCL	Number of Samples Exceeding RBC or MCL
Volatile Organic Compounds						
Carbon disulfide	First	1/4	1.0	1.0	100/NL	0
	Second	0/0	NA	NA		0
	Third	0/0	NA	NA		0
	Fourth	0/1	ND	ND		0
Semivolatile Organic Compounds						
1-Methylnaphthalene	First	2/4	7.0 - 17.0	12.0	150/NL	0
	Second	0/0	NA	NA		0
	Third	0/0	NA	NA		0
	Fourth	0/0	NA	NA		0
2-Methylnaphthalene	First	1/4	5.0	5.0	150/NL	0
	Second	1/2	3.0	3.0		0
	Third	2/2	2.0 - 2.0	2.0		0
	Fourth	0/3	ND	ND		0
Acenaphthene	First	2/4	1.0 - 3.0	2.0	220/NL	0
	Second	2/2	2.0 - 2.0	2.0		0
	Third	2/2	1.0 - 3.0	2.0		0
	Fourth	2/3	2.0 - 3.0	2.5		0
Benzoic acid	First	0/4	ND	ND	15,000/NL	0
	Second	0/2	ND	ND		0
	Third	0/2	ND	ND		0
	Fourth	1/3	4.0	4.0		0
Butylbenzylphthalate	First	0/4	ND	ND	730/NL	0
	Second	0/2	ND	ND		0
	Third	0/2	ND	ND		0
	Fourth	1/3	12.0	12.0		0
Dibenzofuran	First	2/4	1.0 - 1.0	1.0	2.4/NL	0
	Second	1/2	3.0	3.0		1
	Third	1/2	4.0	4.0		1
	Fourth	1/3	2.0	2.0		0
Di-n-butylphthalate	First	1/4	5.0	5.0	370/NL	0
	Second	0/2	ND	ND		0
	Third	0/2	ND	ND		0
	Fourth	0/3	ND	ND		0
Dimethoate	First	1/4	2.0	2.0	0.73/NL	1
	Second	0/0	NA	NA		0
	Third	0/0	NA	NA		0
	Fourth	0/0	NA	NA		0

Table 10.3.6
AOCs 675/676/677
Organic Compound Analysis Results for Groundwater (μg/L)

Parameter	Sample Round	Detection Frequency	Detection Range	Mean	Tap-water RBC/MCL	Number of Samples Exceeding RBC or MCL
Fluorene	First	1/4	1.0	1.0	150/NL	0
	Second	1/2	5.0	5.0		0
	Third	1/2	8.0	8.0		0
	Fourth	1/3	5.0	5.0		0
Naphthalene	First	1/4	1.0	1.0	150/NL	0
	Second	0/2	ND	ND		0
	Third	1/2	1.0	1.0		0
	Fourth	0/3	ND	ND		0
Phenanthrene	First	0/4	ND	ND	110/NL	0
	Second	1/2	2.0	2.0		0
	Third	1/2	2.0	2.0		0
	Fourth	1/3	2.0	2.0		0
TPH-DRO						
Naphtha C6-C12	First	0/0	NA	NA	NA	0
	Second	0/1	ND	ND	NA	0
	Third	0/1	ND	ND	NA	0
	Fourth	1/2	10,200	10,200	NA	0
TPH-GRO						
Gasoline	First	0/0	NA	NA	NA	0
	Second	1/1	115	115	NA	0
	Third	1/1	7.7	7.7	NA	0
	Fourth	1/2	77	77	NA	0
Herbicides						
2,4-D	First	1/1	0.18	0.18	6.1/70	0
	Second	0/0	NA	NA		0
	Third	0/0	NA	NA		0
	Fourth	0/1	ND	ND		0
Organotins, Dioxins, & Furans						
TEQs	First	1/1	3.95E-07	3.95E-07	4.5E-07/3E-05	0
	Second	0/1	ND	ND		0
	Third	0/1	ND	ND		0
	Fourth	0/1	ND	ND		0
1234678-HpCDD	First	1/1	2.47E-06	2.47E-06	4.5E-05/NL	0
	Second	0/1	ND	ND		0
	Third	0/1	ND	ND		0
	Fourth	0/1	ND	ND		0

Table 10.3.6
AOCs 675/676/677
Organic Compound Analysis Results for Groundwater (μg/L)

Parameter	Sample Round	Detection Frequency	Detection Range	Mean	Tap-water RBC/MCL	Number of Samples Exceeding RBC or MCL
OCDD	First	1/1	8.79E-06	8.79E-06	4.5E-04/NL	0
	Second	0/1	ND	ND		0
	Third	0/1	ND	ND		0
	Fourth	0/1	ND	ND		0
123789-HxCDF	First	1/1	3.44E-06	3.44E-06	4.5E-06/NL	0
	Second	0/1	ND	ND		0
	Third	0/1	ND	ND		0
	Fourth	0/1	ND	ND		0
1234678-HpCDF	First	1/1	1.71E-06	1.71E-06	4.5E-05/NL	0
	Second	0/1	ND	ND		0
	Third	0/1	ND	ND		0
	Fourth	0/1	ND	ND		0
OCDF	First	1/1	7.61E-07	7.61E-07	4.5E-04/NL	0
	Second	0/1	ND	ND		0
	Third	0/1	ND	ND		0
	Fourth	0/1	ND	ND		0

Notes:

NA	=	Not Applicable/Not Available/Not Analyzed
ND	=	Not Detected
NL	=	Not Listed
μg/kg	=	micrograms per kilogram
mg/kg	=	milligrams per kilogram

See Table 5.5 for organic compound screening concentrations and their sources.

Table 10.3.7
AOCs 675/676/677
Inorganic Analysis Results for Groundwater (µg/L)

Parameter	Sample Round	Detection Frequency	Detection Range	Mean	Tap-water RBC/MCL	Shallow Groundwater Background	Number of Samples Exceeding Lower of RBC or MCL and Background
Aluminum (Al)	First	0/4	ND	ND	3,700/NL	1,440	0
	Second	2/4	28.2 - 29.5	28.9			0
	Third	0/4	ND	ND			0
	Fourth	0/4	ND	ND			0
Arsenic (As)	First	0/4	ND	ND	0.045/50	23.0	0
	Second	0/4	ND	ND			0
	Third	1/4	6.1	6.1			0
	Fourth	1/4	7.1	7.1			0
Barium (Ba)	First	4/4	21.9 - 40.1	32.6	260/2,000	110	0
	Second	4/4	18.5 - 61.1	35.7			0
	Third	0/4	ND	ND			0
	Fourth	4/4	14.8 - 73.4	43.3			0
Beryllium (Be)	First	0/4	ND	ND	7.30/4	1.1	0
	Second	0/4	ND	ND			0
	Third	0/4	ND	ND			0
	Fourth	4/4	0.31 - 0.70	0.43			0
Cadmium (Cd)	First	4/4	0.30 - 1.1	0.50	1.80/5	NA	0
	Second	0/4	ND	ND			0
	Third	0/4	ND	ND			0
	Fourth	0/4	ND	ND			0
Calcium (Ca)	First	4/4	132,000-526,000	243,000	NL/NL	NL	NA
	Second	4/4	121,000 - 241,000	183,000			NA
	Third	4/4	109,000 - 428,000	231,000			NA
	Fourth	4/4	162,000 - 310,000	245,000			NA
Chromium (Cr)	First	4/4	1.1 - 3.1	1.7	18/100	14.3	0
	Second	1/4	5.4	5.4			0
	Third	0/4	ND	ND			0
	Fourth	1/4	8.6	8.6			0
Cobalt (Co)	First	0/4	ND	ND	220/NL	2.2	0
	Second	0/4	ND	ND			0
	Third	0/4	ND	ND			0
	Fourth	1/4	1.2	1.2			0
Copper (Cu)	First	0/4	ND	ND	150/1,300	4.4	0
	Second	1/4	3.0	3.0			0
	Third	0/4	ND	ND			0
	Fourth	0/4	ND	ND			0
Iron (Fe)	First	3/4	544 -14,700	5,710	NL/NL	NL	NA
	Second	3/4	3,820 - 5,100	4,640			NA
	Third	4/4	1,490 - 16,400	6,400			NA
	Fourth	3/4	65.8 - 13,800	5,660			NA
Lead (Pb)	First	3/4	2.7 - 3.9	3.2	15/15	4.4	0
	Second	0/4	ND	ND			0
	Third	0/4	ND	ND			0
	Fourth	2/4	1.9 - 4.0	3.0			0

Table 10.3.7
AOCs 675/676/677
Inorganic Analysis Results for Groundwater (μg/L)

Parameter	Sample Round	Detection Frequency	Detection Range	Mean	Tap-water RBC/MCL	Shallow Groundwater Background	Number of Samples Exceeding Lower of RBC or MCL and Background
Magnesium (Mg)	First	4/4	23,000 - 647,000	211,000	NL/NL	NL	NA
	Second	4/4	20,300 - 508,000	158,000			NA
	Third	4/4	19,500 - 407,000	145,000			NA
	Fourth	4/4	14,100 - 418,000	130,000			NA
Manganese (Mn)	First	4/4	13.4 - 1,690	496	73/NL	5,430	0
	Second	4/4	8.3 - 301	168			0
	Third	4/4	77.8 - 1,080	434			0
	Fourth	4/4	19.8 - 382	139			0
Nickel (Ni)	First	0/4	ND	ND	73/100	13.3	0
	Second	0/4	ND	ND			0
	Third	2/4	1.8 - 1.8	1.8			0
	Fourth	2/4	1.3 - 4.2	2.8			0
Potassium (K)	First	4/4	26,800 - 320,000	128,000	NL/NL	NL	NA
	Second	4/4	17,500 - 324,000	104,000			NA
	Third	4/4	18,400 - 167,000	70,300			NA
	Fourth	4/4	5,470 - 216,000	69,500			NA
Selenium (Se)	First	0/4	ND	ND	18/50	ND	0
	Second	0/4	ND	ND			0
	Third	0/4	ND	ND			0
	Fourth	1/4	4.4	4.4			0
Sodium (Na)	First	4/4	98,000 - 4,210,000	1,420,000	NL/NL	NL	NA
	Second	4/4	82,700 - 5,320,000	1,670,000			NA
	Third	2/4	585,000 - 1,080,000	832,500			NA
	Fourth	4/4	15,100 - 4,190,000	1,230,000			NA
Thallium (Ti)	First	0/4	ND	ND	0.26/2	2	0
	Second	0/4	ND	ND			0
	Third	0/4	ND	ND			0
	Fourth	1/4	4.6	4.6			1
Vanadium (V)	First	4/4	1.6 - 5.7	2.8	26/NL	14.0	0
	Second	4/4	1.1 - 15.1	5.6			0
	Third	0/4	ND	ND			0
	Fourth	1/4	13.8	13.8			0
Zinc (Zn)	First	2/4	4.7 - 10.2	7.5	1,100/NL	24.4	0
	Second	0/4	ND	ND			0
	Third	0/4	ND	ND			0
	Fourth	0/4	ND	ND			0

Notes:
NA = Not Applicable/Not Available
ND = Not Detected
NL = Not Listed
μg/L = micrograms per liter
See Table 5.6 for inorganic screening concentrations and their sources.

Table 10.3.8
AOCs 675/676/677
Analytes Detected in Shallow Groundwater (μg/L)

Parameter	Location	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Tap-water RBC*	MCL/SMCL*	Shallow Background
Volatile Organic Compounds (μg/L)								
Carbon disulfide	676GW001	1	NT	NT	NT	100	NA	NA
Semivolatile Organic Compounds (μg/L)								
Acenaphthene	675GW001	3	2	1	ND	220	NA	NA
	675GW002	1	2	3	3			
	676GW001	ND	NT	NT	2			
Benzoic acid	675GW002	ND	ND	ND	4	15000	NA	NA
Butylbenzylphthalate	676GW001	ND	NT	NT	12	730	NA	NA
Dibenzofuran	675GW001	1	ND	ND	ND	2.4	NA	
	675GW002	1	3	4	2			
Di-n-butylphthalate	676GW001	5	NT	NT	ND	370	NA	NA
Fluorene	675GW002	1	5	8	5	150	NA	NA
1-Methylnaphthalene	675GW001	7	NT	NT	NT	150	NA	NA
	675GW002	17	NT	NT	NT			
2-Methylnaphthalene	675GW001	ND	3	2	ND	150	NA	NA
	675GW002	5	ND	2	ND			
Naphthalene	675GW002	1	ND	1	ND	150	NA	NA
Phenanthrene	675GW002	ND	2	2	2	110	NA	NA
Organophosphate Pesticides (μg/L)								
Dimethoate	675GW002	2	NT	NT	NT	0.73	NA	NA
Herbicides (μg/L)								
2,4-D	677GW002	0.18	NT	NT	ND	6.1	70	NA

Table 10.3.8
AOCs 675/676/677
Analytes Detected in Shallow Groundwater (μg/L)

Parameter	Location	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Tap-water RBC*	MCL/SMCL*	Shallow Background
TPH-DRO (mg/L)								
Naptha C6 - C12	675GW002	NT	ND	ND	10200	NA	NA	NA
TPH-GRO (mg/L)								
Gasoline	675GW002	NT	115	7.7	77	NA	NA	NA
Dioxin Compounds (pg/L)								
2,3,7,8-TCDD equivalents (TEQs)	677GW001	0.395	ND	ND	ND	0.45	30	NA
1234678-HpCDD	677GW002	2.467	ND	ND	ND	45	NA	NA
OCDD	677GW002	8.794	ND	ND	ND	450	NA	NA
123789-HxCDF	677GW002	3.437	ND	ND	ND	4.5	NA	NA
1234678-HpCDF	677GW002	1.712	ND	ND	ND	45	NA	NA
OCDF	677GW002	0.761	ND	ND	ND	450	NA	NA
Inorganics (μg/L)								
Aluminum (Al)	675GW001	ND	28.2	ND	ND	3700	NL	1440
	676GW001	ND	29.5	ND	ND			
Arsenic (As)	675GW002	ND	ND	ND	7.1	0.045	50	23
	677GW002	ND	ND	6.1	ND			
Barium (Ba)	675GW001	21.9	18.5	ND	14.8	260	2000	110
	675GW002	38.1	36	ND	73.4			
	676GW001	30.3	27.3	ND	27.7			
	677GW002	40.1	61.1	ND	57.3			

Table 10.3.8
AOCs 675/676/677
Analytes Detected in Shallow Groundwater (μg/L)

Parameter	Location	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Tap-water RBC*	MCL/SMCL*	Shallow Background
Beryllium (Be)	675GW001	ND	ND	ND	0.31	7.3	4	1.1
	675GW002	ND	ND	ND	0.36			
	676GW001	ND	ND	ND	0.34			
	677GW002	ND	ND	ND	0.7			
Cadmium (Cd)	675GW001	0.3	ND	ND	ND	1.8	5	NA
	675GW002	0.3	ND	ND	ND			
	676GW001	0.3	ND	ND	ND			
	677GW002	1.1	ND	ND	ND			
Chromium (Cr) (total)	675GW001	1.4	ND	ND	ND	18	100	14.3
	675GW002	1.3	ND	ND	ND			
	676GW001	1.1	ND	ND	ND			
	677GW002	3.1	5.4	ND	8.6			
Cobalt (Co)	677GW002	ND	ND	ND	1.2	220	NL	2.2
Copper (Cu)	675GW002	ND	3	ND	ND	150	1300	4.4
Lead (Pb)	675GW001	3.9	ND	ND	4	15	15	4.4
	675GW002	2.7	ND	ND	1.9			
	677GW002	3	ND	ND	ND			
Manganese (Mn)	675GW001	228	262	246	19.8	73	NL	5430
	675GW002	51.9	99.7	77.8	131			
	676GW001	13.4	8.3	331	22.9			
	677GW002	1690	301	1080	382			

Table 10.3.8
AOCs 675/676/677
Analytes Detected in Shallow Groundwater (μg/L)

Parameter	Location	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Tap-water RBC*	MCL/SMCL*	Shallow Background
Nickel (Ni)	675GW001	ND	ND	ND	4.2	73	100	13.3
	676GW001	ND	ND	1.8	1.3			
	677GW002	ND	ND	1.8	ND			
Selenium (Se)	677GW002	ND	ND	ND	4.4	18	50	ND
Thallium (Tl)	677GW002	ND	ND	ND	4.6	0.26	2	6.6
Vanadium (V)	675GW001	2	1.9	ND	ND	26	NL	14
	675GW002	2	1.1	ND	ND			
	676GW001	1.6	4.1	ND	ND			
	677GW002	5.7	15.1	ND	13.8			
Zinc (Zn)	675GW001	4.7	ND	ND	ND	1100	NL	24.4
	675GW002	10.2	ND	ND	ND			

Notes:
* = Tap-water RBCs (THQ=0.1) from *Risk-Based Concentration Table* (USEPA, October 22, 1997), and MCLs/SMCLs from *Drinking Water Regulations and Health Advisories* (USEPA, 1996e)
1 = Calculated from methods described in USEPA Interim *Supplemental Guidance to RAGS: Human Health Risk Assessment*, Bulletin 2 (USEPA, 1995c)
Bold concentrations exceed the RBCs, SSL, and the zone background
All background values for Zone I are based on twice the means of the grid sample concentrations. Background values for the groundwater are based on two sampling rounds in two wells at each depth.

Three SVOCs were detected during the four sampling rounds at shallow grid-based well GDI015. Diethylphthalate was detected during the second sampling round at 2.0 μg/L. Acenaphthene was detected during the third and fourth sampling rounds at 3.0 μg/L and 4.0 μg/L, respectively. Benzoic acid was detected during the fourth sampling round at 1.0 μg/L. Two SVOCs were detected at deep grid-well GDI15D. Diethylphthalate was detected during the second sampling round at 2.0 μg/L. Benzoic acid was detected during the fourth sampling round at 1.0 μg/L. Diethylphthalate was not detected in wells at the combined AOC. All shallow and deep grid-based groundwater SVOCs were far below their respective tap-water RBCs.

Total Petroleum Hydrocarbons in Groundwater

Beginning with the second round of sampling, groundwater samples from monitoring well 675002 were analyzed for TPH DRO and TPH GRO. Gasoline was detected in this well during the second-, third-, and fourth-sampling rounds at 115 μg/L, 7.7 μg/L, and 77 μg/L, respectively. Naphtha C6-C12 was also detected at this well at 10,200 μg/L in the fourth-sampling round. Monitoring well 675001 was sampled for TPH DRO and TPH GRO during the fourth-sampling round. No petroleum hydrocarbons were detected in these analytical results.

In addition to sampling for petroleum hydrocarbons, a free product sample was collected from monitoring well 675002 during the third sampling round. This sample was analyzed for VOCs, SVOCs, TPH DRO, and TPH GRO. Two VOCs were detected in the free product sample: carbon disulfide (4,400 μg/L) above its tap-water RBC (100 μg/L); and chloroform (1,300 μg/L), above its tap-water RBC and MCL (100 μg/L). Six SVOCs were detected in the free product sample. The tap-water RBCs for 2-methylnaphthalene, fluorene, fluoranthene, and phenanthrene (150 μg/L for each) were exceeded at 280,000 μg/L, 300,000 μg/L, 91,000 μg/L, and 380,000 μg/L, respectively. The tap-water RBC for acenaphthene (220 μg/L) was exceeded at 97,000 μg/L. The tap-water RBC for pyrene (110 μg/L) was exceeded at 65,000 μg/L.

Gasoline was also detected in the free product sample from 675002 at 1,100,000 μg/L.

Pesticides and PCBs in Groundwater

No pesticides or PCBs were detected in groundwater samples from the combined AOC wells.

Two pesticides were detected in the first-round groundwater sample from shallow grid well GDI015: methyl parathion (0.24 μg/L), below its tap-water RBC; and beta BHC (0.1 μg/L), above its tap-water RBC. No pesticides were detected in subsequent sampling rounds at GDI015, and no PCBs were detected in any groundwater samples at GDI015. No pesticides or PCBs were detected in samples from deep grid well GDI15D.

Other Organic Compounds in Groundwater

The herbicide 2,4-D was detected in the first sampling round from monitoring well 677002 (0.18 μg/L) at a concentration far below its tap-water RBC (6.1 μg/L).

In accordance with recent dioxin guidance and Section 7 of this report, a TEQ of 3.95E-07 μg/L was calculated for dioxins in sample 67700201. This concentration is below the tap-water RBC for 2,3,7,8-TCDD (4.5E-07 μg/L). No other groundwater samples at the combined AOCs or grid-based wells GDI015/GDI15D were analyzed for dioxin.

Inorganics in Groundwater

Twenty metals were detected in groundwater in the four sampling rounds at the combined AOCs. Thallium (4.6 μg/L) exceeded its tap-water RBC, MCL, and shallow groundwater background concentration in fourth-round sample 67700204. All other metal concentrations were below their respective tap-water RBCs, MCLs, and shallow background concentrations.

Sixteen metals were detected in groundwater samples from shallow grid-based well GDI015 in the four sampling rounds. Antimony (5.5 μg/L) exceeded its tap-water RBC in the second-round sample results, but was below its MCL. All other metal concentrations from GDI015 were far below their respective tap-water RBCs, MCLs, or shallow background concentrations.

Twelve metals plus cyanide were detected in groundwater samples from deep grid-based well GDI15D in the four sampling rounds. Thallium (7.1 μg/L) exceeded its tap-water RBC, MCL, and shallow background concentration in the third-round sample results. All other metal concentrations from GDI15D were far below their respective tap-water RBCs, MCLs, and deep background concentrations.

10.3.5 Sediment Sampling and Analysis

The approved final RFI work plan proposed a sediment sample be collected from the area near the oil/water separator (adjacent to Facility NS-4) for TOC and grain size analysis. Sample 675M000101 was collected in the area described, from a shallow depression where precipitation runoff settles. In addition to TOC and grain size, this sample was also analyzed for the standard suite of parameters, plus organotins. Table 10.3.9 summarizes the sediment sampling event.

Table 10.3.9
AOCs 675, 676 and 677
Sediment Sampling Summary

Sampling Round	Sampling Date	Samples Collected	Sample Analyses	Comments
1	06/22/95	1 (1)	Standard Suite, Organotins, TOC, Grain Size	

Notes:
( ) = Parentheses indicate number of samples proposed in the final RFI work plan.
Standard Suite = VOCs, SVOCs, metals, cyanide, pesticides, and PCBs at DQO Level III.

10.3.6 Nature and Extent of Contamination in Sediment

Table 10.3.10 summarizes the organic analytical results for sediment. Table 10.3.11 summarizes the inorganic analytical results for sediment. Analytes detected in the sediment are included in the Table 10.3.4 summary. The analytical results are included in Appendix D.

Table 10.3.10
AOCs 675/676/677
Organic Analytical Results for Sediment (μg/kg)

Parameter	Frequency of Frequency	Range of Detection	Mean of Detection
Volatile Organic Compounds			
Acetone	1/1	95.0	95.0
Semivolatile Organic Compounds			
Pyrene	1/1	730	730
bis(2-Ethylhexyl)phthalate (BEHP)	1/1	840	840
Pesticides and PCBs			
4,4'-DDD	1/1	6.5	6.5
4,4'-DDE	1/1	2.0	2.0
4,4'-DDT	1/1	2.8	2.8
Aldrin	1/1	0.34	0.34
Dieldrin	1/1	3.7	3.7
Endosulfan I	1/1	12.0	12.0
Endosulfan II	1/1	5.5	5.5
Endosulfan sulfate	1/1	2.0	2.0
Endrin	1/1	12.0	12.0
Endrin aldehyde	1/1	8.8	8.8
Heptachlor epoxide	1/1	4.0	4.0
Methoxychlor	1/1	6.6	6.6
alpha-BHC	1/1	0.59	0.59
gamma-BHC	1/1	1.2	1.2

Notes:
NL = Not Listed
NA = Not Applicable/Not Available/Not Analyzed
μg/kg = micrograms per kilogram

Table 10.3.11
AOCs 675/676/677
Inorganic Analytical Results for Sediment (mg/kg)

Parameter	Frequency of Detection	Range of Detection	Mean of Detection
Aluminum (Al)	1/1	3,190	3,190
Antimony (Sb)	1/1	0.22	0.22
Arsenic (As)	1/1	0.52	0.52
Barium (Ba)	1/1	12.4	12.4
Calcium (Cd)	1/1	3,460	3,460
Chromium (Cr)	1/1	10.9	10.9
Cobalt (Co)	1/1	0.63	0.63
Copper (Cu)	1/1	14.9	14.9
Iron (Fe)	1/1	3,680	3,680
Lead(Pb)	1/1	30.1	30.1
Magnesium (Mg)	1/1	333	333
Manganese (Mn)	1/1	23.9	23.9
Nickel (Ni)	1/1	16.6	16.6
Potassium (K)	1/1	156	156
Sodium (Na)	1/1	276	276
Tin (Sn)	1/1	1.9	1.9
Zinc (Zn)	1/1	66.2	66.2

Notes:
NL = Not Listed
NA = Not Applicable/Not Available/Not Analyzed
mg/kg = milligrams per kilogram

Volatile Organic Compounds in Sediment

Acetone (95.0 μg/kg) was the only VOC detected in sediment sample 675M000101.

Semivolatile Organic Compounds in Sediment

Two SVOCs – pyrene (730 μg/kg) and bis(2-ethylhexyl)phthalate (840 μg/kg) – were detected in the sediment sample.

Pesticides and PCBs in Sediment

Fourteen pesticides were detected in the sediment sample.

Inorganics in Sediment

Seventeen metals were detected in the sediment sample.

10.3.7 Fate and Transport Assessment for AOCs 675, 676, and 677

AOC 675 is located at Facility NS-4, and consists of a 25,000 gallon UST. This UST stored Number-five and Number-two fuel oil and began operations in 1952. After construction of nearby Building NS-2 (a boiler house) in 1958, Facility NS-4 provided fuel to boilers in this building. A 495 gallon oil/water separator is located north of this UST. Also, potential surface and subsurface petroleum contamination may have occurred from previous use of the AOC 675 area to refuel seaplanes. AOC 676 is the location of a former incinerator, which operated near the current location of Building NS-2. The incinerator was used during the 1940s, and no records exist concerning its design and operation. The types of materials burned in the incinerator are unknown, but may have included flammable hazardous materials (paints, solvents, waste oils), as well as paper, wood, and general trash. AOC 677 consists of the grounds surrounding Building NS-2. The original boilers housed in Building NS-2 were replaced with newer ones in 1977. Number-five fuel oil was used to fuel these boilers until 1991, when conversion was made to the cleaner burning number-two fuel oil. This fuel was stored in the nearby 25,000 gallon UST at Facility NS-4 (AOC 675). Prior to 1979 the sump pump for the boilers discharged to the base storm sewer system. After 1979, the sump pump discharged to the sanitary sewer system via an oil/water separator. There was a history of documented fuel oil spills at this site, ranging from 3 to 500 gallons in size.

Environmental media sampled as part of this investigation included surface soil, subsurface soil, sediment, and shallow groundwater. Potential migration pathways investigated for

AOCs 675/676/677 are soil-to-groundwater, soil-to-sediment, groundwater migration to human receptors and to surface water, and emission of volatiles from soil-to-air.

10.3.7.1 Soil-to-Groundwater Cross-Media Transport

Tables 10.3.12 and 10.3.13 compare maximum detected organic and inorganic constituent concentrations, respectively, in surface and subsurface soil samples to risk-based soil screening levels considered protective of groundwater. Maximum concentrations in soil are compared to leachability-based generic SSLs. Soil background values for inorganics in Zone I were determined, but at the request of SCDHEC these were not considered during initial comparisons of maximum soil concentrations with SSLs. Generic SSLs are used to provide a conservative screen; leachate entering the aquifer is assumed to be diluted by a ratio of 10:1, with no attenuation of constituents in soil (DAF=10).

No inorganic constituents were detected in AOC 675/676/677 surface or subsurface soil at concentrations exceeding groundwater protection SSLs. Four inorganics – antimony, chromium, manganese, and thallium – were detected above applicable SSLs in surface and subsurface soil. Antimony was detected above its SSL in one of 14 surface soil samples and three of eight subsurface soil samples, with surface and subsurface exceedances coincident at only one location (676SB002). Figure 10.3.2 presents antimony concentrations detected at AOCs 675/676/677. Antimony was not detected in shallow groundwater. Chromium was widely detected in the surface and subsurface soil, exceeding the SSL in 13 of 14 surface samples and all eight subsurface samples. Only two samples exceeded the zone-specific background. Figure 10.3.3 presents chromium concentrations detected at AOCs 656/676/677. While chromium was present in shallow groundwater, it was at concentrations less than the RBC and background. Manganese was also widely detected in soil, but exceeded the SSL in only one surface sample. Figure 10.3.4 presents

Table 10.3.12
Organic Chemicals Detected in Surface Soil, Subsurface Soil, Sediment, and Shallow Groundwater
Comparison to Cross-Media SSLs, Tap-water RBCs, and Saltwater Surface Water Chronic Screening Levels
AOCs 675/676/677
Charleston Naval Complex
Charleston, South Carolina

Parameter	Maximum Concentration				Screening Concentration									
	Surface Soil	Subsurface Soil	Sediment	Shallow GW	Soil to GW SSL	Soil to Air SSL	Tap Water RBC	Saltwater Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Volatil-ization Potential	Ground-water Migration Concern	Surface Water Migration Concern
Volatile Organic Compounds														
Acetone	72	200	95	ND	8000	1.0E+08	3700	NA	µG/KG	µG/L	NO	NO	NO	NO
Acetonitrile	100	150	ND	ND	440 a	NA	220	NA	µG/KG	µG/L	NO	NO	NO	NO
Carbon disulfide	ND	ND	ND	1	16000	720000	1000	NA	µG/KG	µG/L	NO	NO	NO	NO
Toluene	6	23	ND	ND	6000	650000	750	37	µG/KG	µG/L	NO	NO	NO	NO
Semivolatile Organic Compounds														
Acenaphthene	110	2300	ND	3	290000	NA	2200	9.7	µG/KG	µG/L	NO	NO	NO	NO
Anthracene	110	930	ND	ND	5900000	NA	11000	NA	µG/KG	µG/L	NO	NO	NO	NO
Benzoic acid	ND	ND	ND	4	200000	NA	150000	NA	µG/KG	µG/L	NO	NO	NO	NO
Benzo(a)pyrene Equivalents	478	252	ND	ND	1600 a	NA	0.0092	NA	µG/KG	µG/L	NO	NO	NO	NO
Benzo(a)anthracene c	720	480	ND	ND	800	NA	0.092	NA	µG/KG	µG/L	NO	NO	NO	NO
Benzo(a)pyrene c	330	180	ND	ND	4000	NA	0.0092	NA	µG/KG	µG/L	NO	NO	NO	NO
Benzo(b)fluoranthene c	670	220	ND	ND	2500	NA	0.092	NA	µG/KG	µG/L	NO	NO	NO	NO
Benzo(k)fluoranthene c	840	190	ND	ND	25000	NA	0.92	NA	µG/KG	µG/L	NO	NO	NO	NO
Chrysene c	640	420	ND	ND	80000	NA	9.2	NA	µG/KG	µG/L	NO	NO	NO	NO
Butylbenzylphthalate	ND	ND	ND	12	930000	930000	7300	29.4	µG/KG	µG/L	NO	NO	NO	NO
Dibenzofuran	ND	1800	ND	4	6800 a	120000	24	NA	µG/KG	µG/L	NO	NO	NO	NO
Di-n-butylphthalate	35	ND	ND	5	2300000	2300000	3700	3.4	µG/KG	µG/L	NO	NO	NO	YES
bis(2-Ethylhexyl)phthalate (BEHP) c	84	ND	840	ND	1800000	31000000	4.8	NA	µG/KG	µG/L	NO	NO	NO	NO
Fluoranthene	1000	2800	ND	ND	2100000	NA	1500	1.6	µG/KG	µG/L	NO	NO	NO	NO
Fluorene	ND	2200	ND	8	280000	NA	1500	NA	µG/KG	µG/L	NO	NO	NO	NO
1-Methylnaphthalene	210	1700	ND	17	72000 a	NA	1500	NA	µG/KG	µG/L	NO	NO	NO	NO
2-Methylnaphthalene	200	1900	ND	5	230000 a	NA	1500	23.5	µG/KG	µG/L	NO	NO	NO	NO
Naphthalene	2200	5900	ND	1	42000	NA	1500	23.5	µG/KG	µG/L	NO	NO	NO	NO
Phenanthrene	55	6200	ND	2	660000 a	NA	1100	NA	µG/KG	µG/L	NO	NO	NO	NO
Pyrene	810	1900	730	ND	2100000	NA	1100	NA	µG/KG	µG/L	NO	NO	NO	NO
Pesticides/PCBs														
Aldrin c	ND	ND	0.34	ND	230	3000	0.0039	0.13	µG/KG	µG/L	NO	NO	NO	NO
Aroclor-1260 c	61	ND	ND	ND	1000	1000	0.033	0.03	µG/KG	µG/L	NO	NO	NO	NO
alpha-BHC (alpha-HCH) c	ND	ND	0.59	ND	0.25	800	0.011	1400	µG/KG	µG/L	NO	NO	NO	NO
beta-BHC (beta-HCH) c	1.3	ND	ND	ND	1.3	1E+09	0.037	NA	µG/KG	µG/L	NO	NO	NO	NO
delta-BHC (delta-HCH) c	1.1	ND	ND	ND	1.8 a	NA	0.037	NA	µG/KG	µG/L	NO	NO	NO	NO

Table 10.3.12
Organic Chemicals Detected in Surface Soil, Subsurface Soil, Sediment, and Shallow Groundwater
Comparison to Cross-Media SSLs, Tap-water RBCs, and Saltwater Surface Water Chronic Screening Levels
AOCs 675/676/677
Charleston Naval Complex
Charleston, South Carolina

Parameter	Maximum Concentration: Surface Soil	Maximum Concentration: Subsurface Soil	Maximum Concentration: Sediment	Maximum Concentration: Shallow GW	Screening Concentration: Soil to GW SSL	Screening Concentration: Soil to Air SSL	Screening Concentration: Tap Water RBC	Screening Concentration: Saltwater Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Volatilization Potential	Groundwater Migration Concern	Surface Water Migration Concern
gamma-BHC (Lindane) c	1.2	ND	1.2	ND	4.5	NA	0.052	0.016	µG/KG	µG/L	NO	NO	NO	NO
Chlordane c	7.6	ND	ND	ND	5000	20000	0.19	0.004	µG/KG	µG/L	NO	NO	NO	NO
4,4'-DDD c	34	500	6.5	ND	8000	NA	0.28	0.025	µG/KG	µG/L	NO	NO	NO	NO
4,4'-DDE c	38	240	2	ND	27000	NA	0.2	0.14	µG/KG	µG/L	NO	NO	NO	NO
4,4'-DDT c	24	71	2.8	ND	16000	1E+09	0.2	0.001	µG/KG	µG/L	NO	NO	NO	NO
Dieldrin c	ND	ND	3.7	ND	2	1000	0.0042	0.0019	µG/KG	µG/L	NO	NO	NO	NO
Endosulfan I	ND	ND	12	ND	9000 b	NA	220	0.0087	µG/KG	µG/L	NO	NO	NO	NO
Endosulfan II	ND	ND	5.5	ND	9000 b	NA	220	0.0087	µG/KG	µG/L	NO	NO	NO	NO
Endosulfan sulfate	ND	ND	2	ND	4600 a	NA	220	NA	µG/KG	µG/L	NO	NO	NO	NO
Endrin	2.8	ND	12	ND	500	NA	11	0.0023	µG/KG	µG/L	NO	NO	NO	NO
Endrin aldehyde	1.6	ND	8.8	ND	340 a	NA	11	NA	µG/KG	µG/L	NO	NO	NO	NO
Heptachlor epoxide c	3	ND	4	ND	330	5000	0.0012	0.0036	µG/KG	µG/L	NO	NO	NO	NO
Methoxychlor	ND	ND	6.6	ND	80000	NA	180	0.03	µG/KG	µG/L	NO	NO	NO	NO
Organophosphate Pesticides														
Dimethoate	ND	NA	NA	2	15 a	NA	7.3	NA	µG/KG	µG/L	NO	NO	NO	NO
Herbicides														
2,4-D	ND	NA	NA	0.18	370 a	7000000	61	NA	µG/KG	µG/L	NO	NO	NO	NO
Organotin														
Tetrabutyltin	25.28	ND	ND	ND	NA	NA	11	NA	µG/KG	µG/L	NO	NO	NO	NO
TPH - GRO														
Gasoline	NA	NA	NA	115	NA	NA	NA	NA	µG/KG	µG/L	NO	NO	NO	NO
Dioxin Compounds														
2,3,7,8-TCDD equivalents (TEQs) c	2.02	NA	NA	0.395	1600 a	NA	0.45	10	NG/KG	PG/L	NO	NO	NO	NO
123678-HxCDD	1.09	NA	NA	ND	4100 a	NA	4.5	NA	NG/KG	PG/L	NO	NO	NO	NO
123789-HxCDD	0.92	NA	NA	ND	4100 b	NA	4.5	NA	NG/KG	PG/L	NO	NO	NO	NO
1234678-HpCDD	95.6	NA	NA	2.47	108000 a	NA	45	NA	NG/KG	PG/L	NO	NO	NO	NO
OCDD	926	NA	NA	8.79	1080000 a	NA	450	NA	NG/KG	PG/L	NO	NO	NO	NO
123478-HxCDF	2.06	NA	NA	ND	216000 a	NA	4.5	NA	NG/KG	PG/L	NO	NO	NO	NO
123678-HxCDF	0.837	NA	NA	ND	216000 b	NA	4.5	NA	NG/KG	PG/L	NO	NO	NO	NO

Table 10.3.12
Organic Chemicals Detected in Surface Soil, Subsurface Soil, Sediment, and Shallow Groundwater
Comparison to Cross-Media SSLs, Tap-water RBCs, and Saltwater Surface Water Chronic Screening Levels
AOCs 675/676/677
Charleston Naval Complex
Charleston, South Carolina

Parameter	Maximum Concentration Surface Soil	Subsurface Soil	Sediment	Shallow GW	Screening Concentration Soil to GW SSL	Soil to Air SSL	Tap Water RBC	Saltwater Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Volatilization Potential	Groundwater Migration Concern	Surface Water Migration Concern
123789-HxCDF	ND	NA	NA	3.44	216000 b	NA	4.5	NA	NG/KG	PG/L	NO	NO	NO	NO
234678-HxCDF	0.863	NA	NA	ND	216000 b	NA	4.5	NA	NG/KG	PG/L	NO	NO	NO	NO
1234678-HpCDF	16.6	NA	NA	1.71	54000 a	NA	45	NA	NG/KG	PG/L	NO	NO	NO	NO
OCDF	21.5	NA	NA	0.761	540000 a	NA	450	NA	NG/KG	PG/L	NO	NO	NO	NO

Notes:
Sources of screening concentrations appear in Table 5.5
Explanations of fate and transport screening procedures appear in Section 6.2.
Frequency and range of detections, average detected concentrations, and number of screening concentration exceedances appear in Tables 10.3.2, 10.3.6, and 10.3.10.

a - Calculated soil to groundwater SSL value (See Table 6.2)
b - Based on surrogate compound; see Table 5.5
c - Carcinogenic
GW - Groundwater

NA - Not applicable/not available
ND - Not detected
RBC - Risk-based concentration
SSL - Soil screening level

NG/KG - Nanograms per kilogram
μG/KG - Micrograms per kilogram
PG/L - Picograms per liter
μG/L - Micrograms per liter

Table 10.3.13
Inorganic Chemicals Detected in Surface Soil, Subsurface Soil, Sediment, and Shallow Groundwater
Comparison to Cross-Media SSLs, Tap-Water RBCs, Saltwater Surface Water Chronic Screening Levels, and Background Values
AOCs 675/676/677
Charleston Naval Complex,
Charleston, South Carolina

Parameter	Maximum Concentration Surface Soil	Subsurface Soil	Sediment	Shallow GW	Screening Concentration Soil to GW SSL	Soil Background	Soil to Air SSL	Tap Water RBC	Shallow GW Background	Saltwater Surf. Wtr Chronic	Soil Units	Water Units	Leaching Potential	Fugitive Particulate Inhalation Concern	Ground-water Migration Concern	Surface Water Migration Concern
Inorganic Chemicals																
Aluminum (Al)	11800	24900	3190	29.5	560000 a	27400	NA	37000	1440	NA	MG/KG	µG/L	NO	NO	NO	NO
Antimony (Sb)	6.6	9.2	0.22	ND	2.7	ND	NA	15	NA	NA	MG/KG	µG/L	YES	NO	NO	NO
Arsenic (As) c	5.4	14.4	0.52	7.1	15	21.6	750	0.045	23	36	MG/KG	µG/L	NO	NO	NO	NO
Barium (Ba)	25.7	33	12.4	73.4	820	54.2	690000	2600	110	NA	MG/KG	µG/L	NO	NO	NO	NO
Beryllium (Be)	0.98	1.1	ND	0.7	32	0.95	1300	73	1.1	NA	MG/KG	µG/L	NO	NO	NO	NO
Cadmium (Cd)	0.72	1.2	ND	1.1	4	0.61	1800	18	NA	9.3	MG/KG	µG/L	NO	NO	NO	NO
Chromium (Cr) (total)	70.5	46.1	10.9	8.6	19	51.3	270	180	14.3	50	MG/KG	µG/L	YES	NO	NO	NO
Chromium (Cr6) (hexavalent)	0.426	NA	NA	ND	19	ND	270	180	ND	50	MG/KG	µG/L	NO	NO	NO	NO
Cobalt (Co)	4.4	7.4	0.63	1.2	990 a	5.8	NA	2200	2.2	NA	MG/KG	µG/L	NO	NO	NO	NO
Copper (Cu)	26.6	278	14.9	3	5600 a	240	NA	1500	4.4	2.9	MG/KG	µG/L	NO	NO	NO	YES
Lead (Pb)	42.4	20.2	30.1	4	400	203	400	15	4.4	8.5	MG/KG	µG/L	NO	NO	NO	NO
Manganese (Mn)	1420	188	23.9	1690	480 a	419	NA	730	5430	NA	MG/KG	µG/L	YES	NO	NO	NO
Mercury (Hg)	0.11	0.2	ND	ND	1	0.47	10	11	NA	0.025	MG/KG	µG/L	NO	NO	NO	NO
Nickel (Ni)	20.9	21.1	16.6	4.2	65	23.9	13000	730	13.3	8.3	MG/KG	µG/L	NO	NO	NO	NO
Selenium (Se)	0.97	2.1	ND	4.4	2.6	1.77	NA	180	ND	71	MG/KG	µG/L	NO	NO	NO	NO
Thallium (Tl)	0.42	0.57	ND	4.6	0.36	ND	NA	2.6	2	21.3	MG/KG	µG/L	YES	NO	YES	NO
Tin (Sn)	2.4	11.2	1.9	ND	5500 a	7.5	NA	22000	NA	NA	MG/KG	µG/L	NO	NO	NO	NO
Vanadium (V)	176	57.1	ND	15.1	3000	113	NA	260	14	NA	MG/KG	µG/L	NO	NO	NO	NO
Zinc (Zn)	130	76.7	66.2	10.2	6200	206	NA	11000	24.4	86	MG/KG	µG/L	NO	NO	NO	NO

Notes:
Sources of screening concentrations appear in Table 5.6
Explanations of fate and transport screening procedures appear in Section 6.2.
Frequency and range of detections, average detected concentrations, and number of screening concentration exceedances appear in Tables 10.3.3, 10.3.7, and 10.3.11.

Background values for soil are shown for comparison purposes only.
Maximum groundwater concentrations are screened against the greater of tap water RBCs or corresponding background values to determine groundwater migration concern.

a - Calculated soil to groundwater SSL value (See Table 6.2)
c - Carcinogenic
GW - Groundwater

NA - Not available/Not applicable
ND - Not detected
RBC - Risk-based concentration

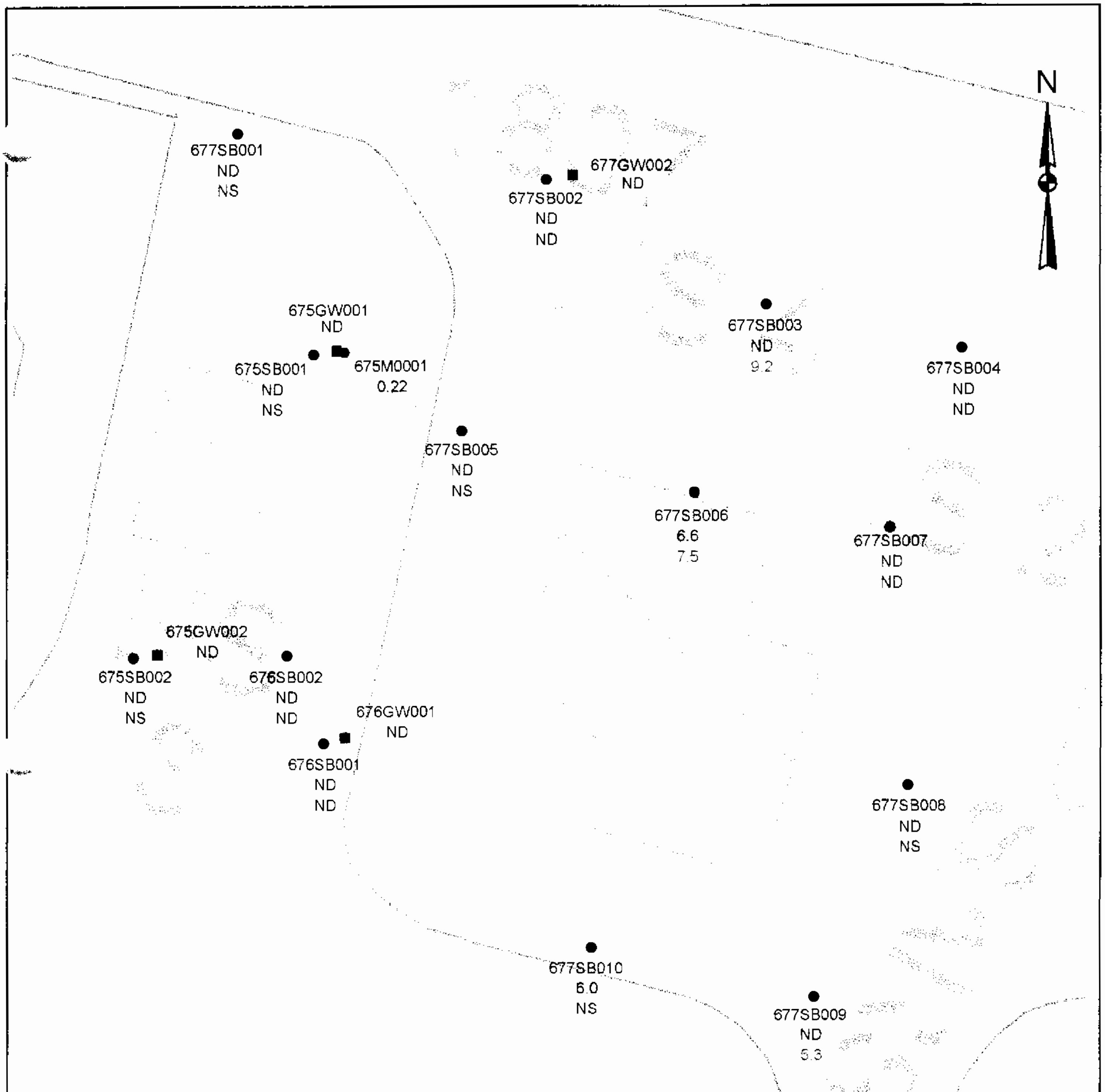
SSL - Soil screening level
MG/KG - Milligrams per kilogram
µG/L - Micrograms per liter

manganese concentrations detected at AOCs 675/676/677. In site groundwater, manganese was present above the RBC but not above the zone-specific background. Thallium exceeded the SSL in one surface soil and three subsurface soil samples, and was present above the RBC and zone background in groundwater. Figure 10.3.5 presents thallium concentrations detected at AOCs 675/676/677.

These inorganics are not typically considered to be associated with petroleum storage and transfer, the past site activities, but they could be associated with the incineration that took place at AOC 676. The distribution of the individual constituents, however, is not particularly unique to AOC 676, which suggests other origins.

The relative distributions of the inorganic constituents do not demonstrate a remarkable trend. The low concentrations of antimony in soil and its sporadic occurrence indicate a small residual mass that is unlikely to be significant; this is further substantiated by its absence in groundwater. The widespread occurrence of chromium and manganese suggest that their presence is not specific to activity at any one AOC, but related to all through a common process or feature - most likely as the result of natural occurrence. This is substantiated by their zone-specific background concentrations. As with antimony, the sporadic occurrence and low concentrations of thallium suggest that the mass in soil should not pose a significant threat to groundwater.

The presence of chromium, manganese, and thallium in groundwater indicates that the soil-to-groundwater pathway has merit, but the distribution of these constituents does not summarily demonstrate the site as the particular source. The area has been filled with non-native material, with a component of finer-grained silts and clays that typically hold inorganics easily sorbed. Also,the combined AOC area is immediately adjacent to the estuarine Cooper River, and exposure to brackish water in the subsurface can lead to many types of mobilizing reactions which can



LEGEND

●	ZONE I SEDIMENT SAMPLE LOCATION
■	MONITORING WELL LOCATION
●	ZONE I SOIL BORING LOCATION
12.30	ZONE I SURFACE SOIL CONC. (MG/KG)
12.30	ZONE I SUBSURFACE SOIL CONC. (MG/KG)
12.30	MAXIMUM QUARTERLY GW CONC. (UG/L)
NS	NO SAMPLE TAKEN
ND	NON DETECT

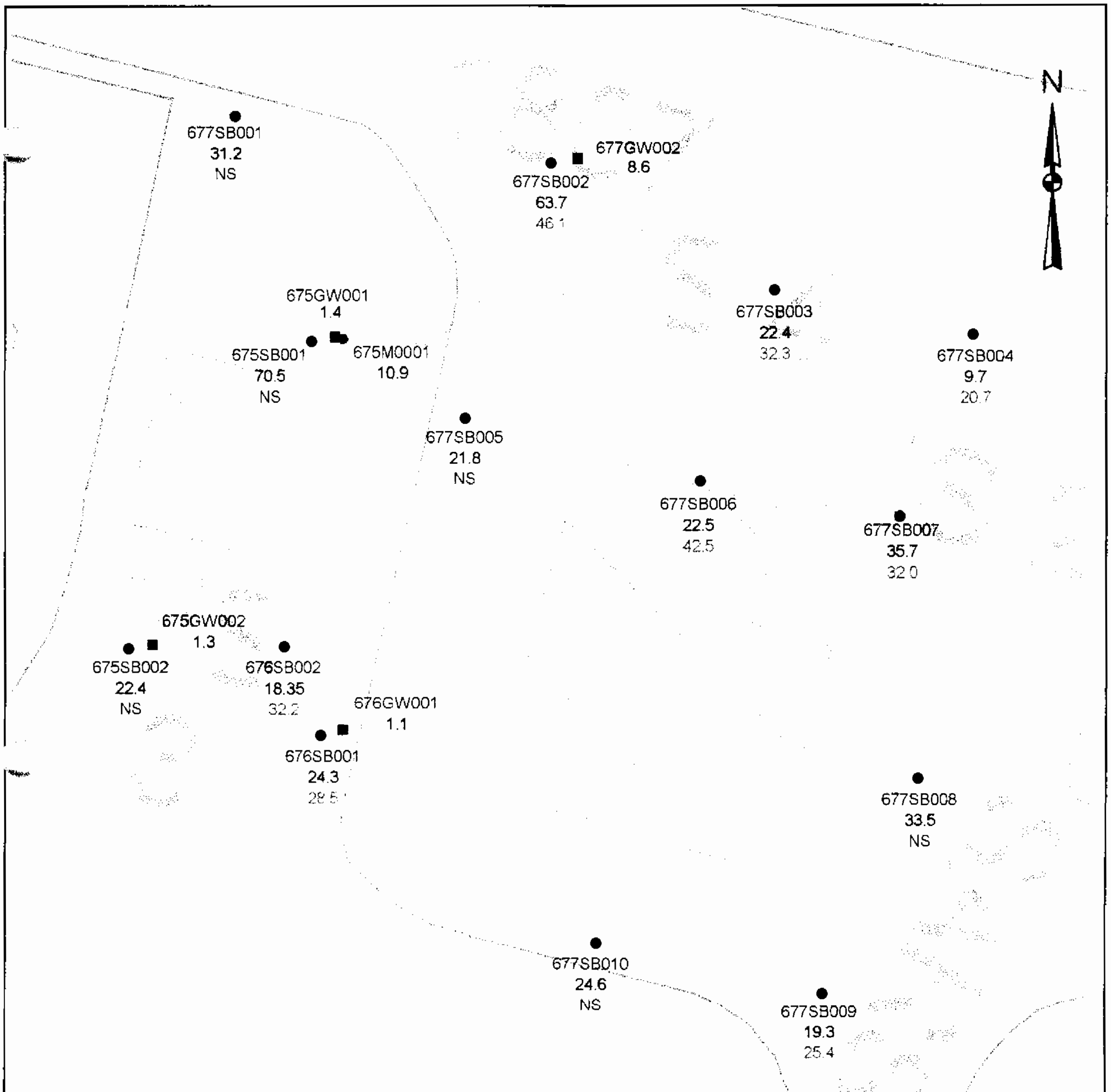
SCALE

20 0 20 40 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.3.2
ZONE I
AOC 675, 676, 677
ANTIMONY
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=6 UG/L RBC=3.1 MG/KG SSL=2.7 MG/KG



LEGEND

•	ZONE I SEDIMENT SAMPLE LOCATION
■	MONITORING WELL LOCATION
●	ZONE I SOIL BORING LOCATION
12.30	ZONE I SURFACE SOIL CONC. (MG/KG)
12.30	ZONE I SUBSURFACE SOIL CONC. (MG/KG)
12.30	MAXIMUM QUARTERLY GW CONC. (UG/L)
NS	NO SAMPLE TAKEN
ND	NON DETECT

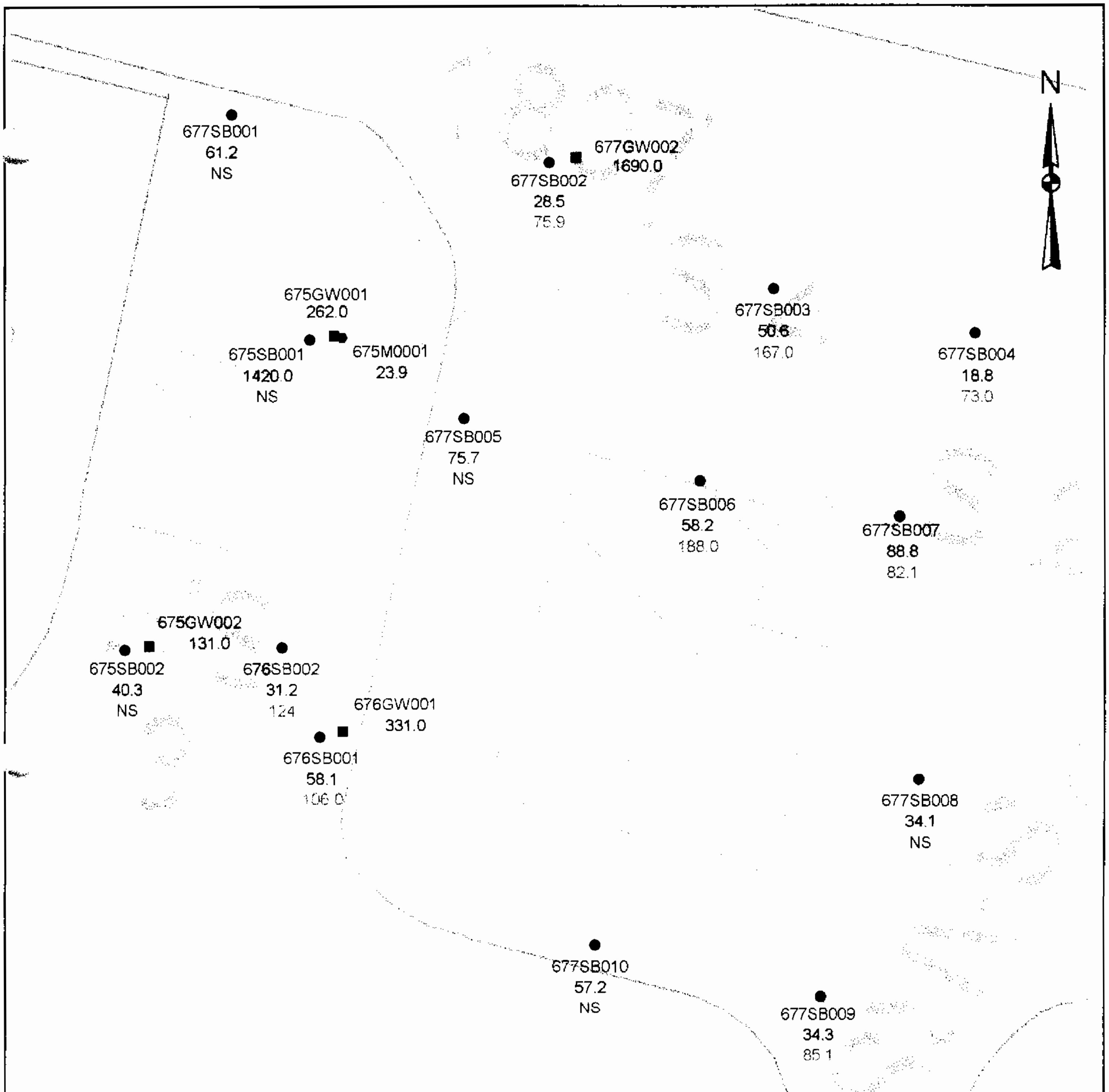
SCALE

20 0 20 40 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.3.3
ZONE I
AOC 675, 676, 677
CHROMIUM
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=100 UG/L RBC=39 MG/KG SSL=19 MG/KG



LEGEND

- ZONE I SEDIMENT SAMPLE LOCATION
- MONITORING WELL LOCATION
- ZONE I SOIL BORING LOCATION

12.30	ZONE I SURFACE SOIL CONC. (MG/KG)
12.30	ZONE I SUBSURFACE SOIL CONC. (MG/KG)
12.30	MAXIMUM QUARTERLY GW CONC. (UG/L)
NS	NO SAMPLE TAKEN
ND	NON DETECT

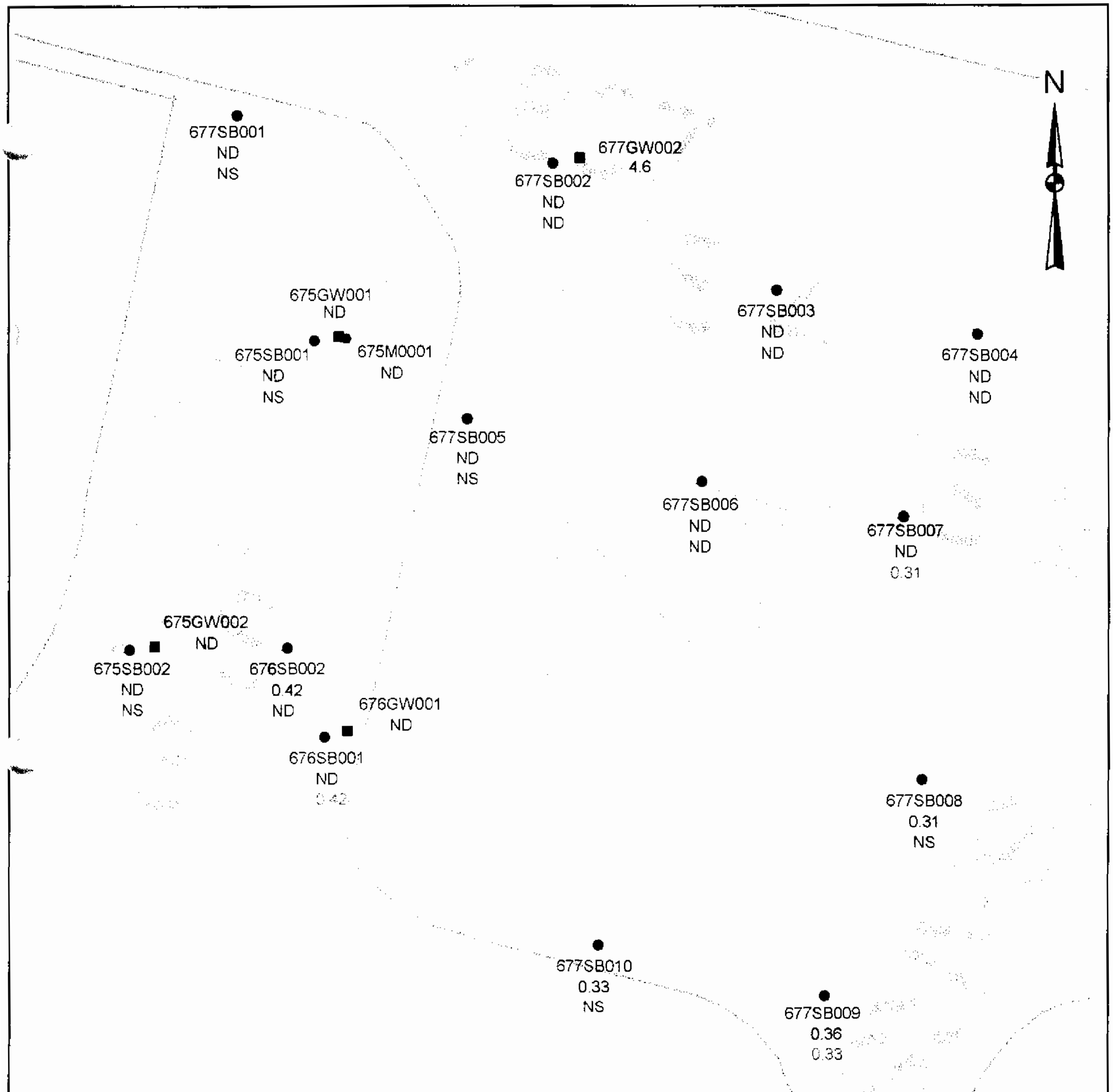
SCALE

20 0 20 40 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.3.4
ZONE I
AOC 675, 676, 677
MANGANESE
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=NA RBC=160 MG/KG SSL=480 MG/KG



LEGEND

●	ZONE I SEDIMENT SAMPLE LOCATION
■	MONITORING WELL LOCATION
●	ZONE I SOIL BORING LOCATION
12.30	ZONE I SURFACE SOIL CONC. (MG/KG)
12.30	ZONE I SUBSURFACE SOIL CONC. (MG/KG)
12.30	MAXIMUM QUARTERLY GW CONC. (UG/L)
NS	NO SAMPLE TAKEN
ND	NON DETECT

SCALE

20 0 20 40 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.3.5
ZONE I
AOC 675, 676, 677
THALLIUM
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=2 UG/L RBC=.55 MG/KG SSL=.36 MG/KG

release inorganics to the groundwater system. The presence of inorganics in groundwater is therefore not straightforward in a near-surface brackish water environment that can be highly variable in terms of Eh, pH, and metals solubility.

10.3.7.2 Groundwater Migration and Surface Water Cross-Media Transport

Tables 10.3.12 and 10.3.13 compare maximum detected organic and inorganic constituent concentrations, respectively, in shallow groundwater samples to risk-based concentrations for drinking water, and to chronic ambient saltwater surface water quality criteria values for the protection of aquatic life (saltwater surface water chronic screening values). For inorganics, maximum concentrations in groundwater are screened against saltwater chronic values and the greater of (a) risk-based drinking water concentrations and (b) corresponding background reference concentrations for groundwater. To provide a conservative screening, no attenuation or dilution of constituents in groundwater is assumed before comparison to the relevant standards. It should be noted that the risk-based pathway for shallow groundwater is currently an invalid pathway simply because there is no human consumption of the groundwater. This comparison is made for screening only, and to develop strategies for long-term management of the groundwater should an area containing deleterious levels be identified.

No organic constituents were present in groundwater at concentrations exceeding the applicable RBC screening levels.

Two inorganic constituents - manganese and thallium - were present in groundwater at levels that exceeded the applicable drinking water risk-based migration pathway criteria (Figures 10.3.4 and 10.3.5). Manganese concentrations were detected in all wells every round, but did not exceed zone-specific background in any round. Thallium was not detected prior to the fourth-round of sampling, and was detected in only one well in the fourth-round. The presence of manganese and thallium in site groundwater is not unexpected given the soil concentrations, but the inconsistent detection of thallium is problematic. It may reflect climatological factors or the complex chemical and stability relationships in the brackish near-surface aqueous environment.

Groundwater flow in the site area is generally towards the adjacent Cooper River, where it undergoes non-point source discharge. Two constituents – di-n-butylpthalate and copper – were identified in site groundwater above the surface water screening criteria. Figures 10.3.6 and 10.3.7 present respectively, di-n-butylpthalate and copper concentrations detected at AOCs 675/676/677. For both constituents, detections were in a single well; di-n-butylpthalate in the first-round and copper in the second-round of sampling. Sample results since that event have been non-detect for both constituents. As a result, the pathway is considered invalid from a chemical standpoint.

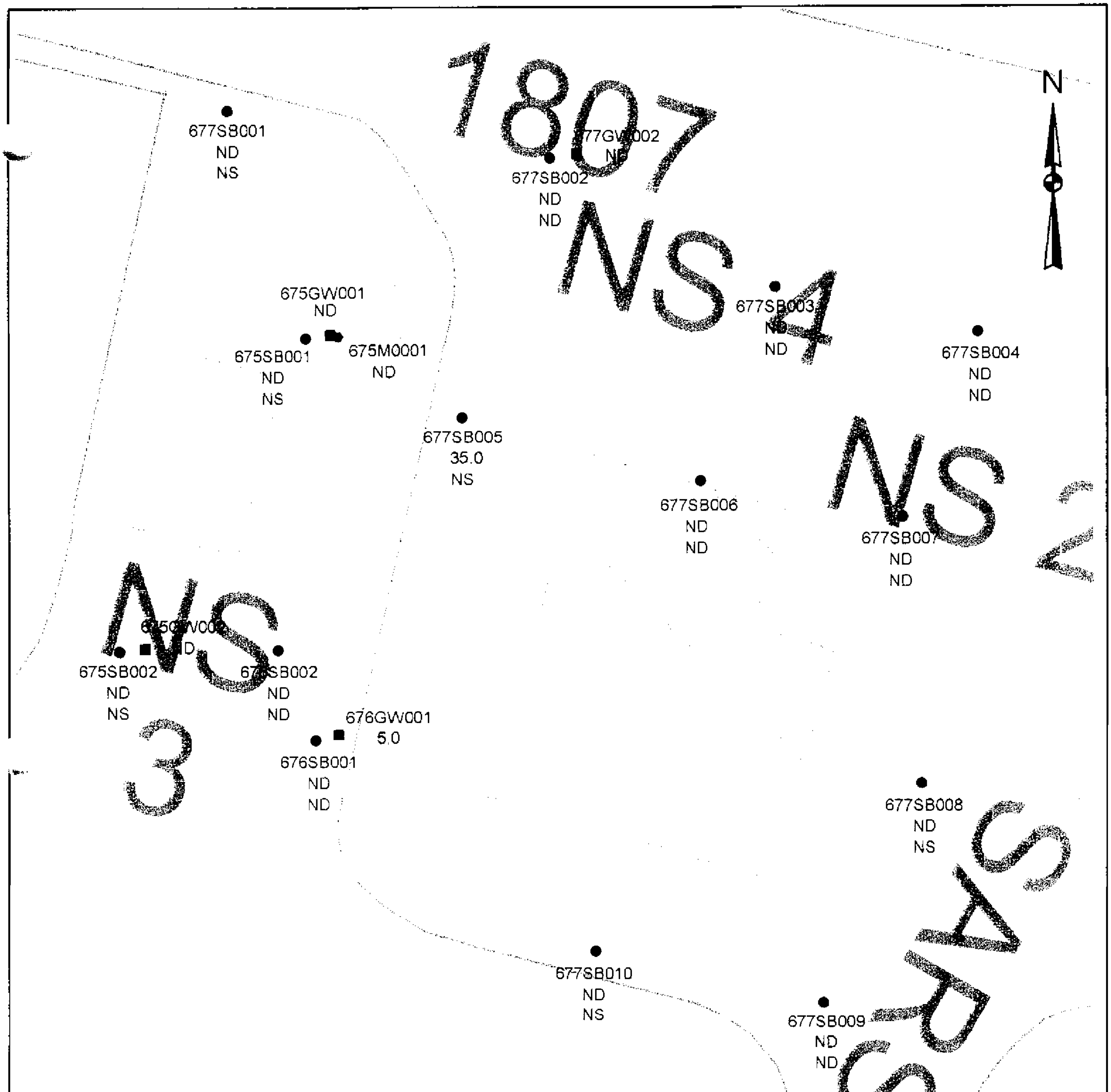
10.3.7.3 Soil-to-Sediment Cross-Media Transport

Analytical results for sediment were compared to those for surface soil to ascertain the potential relationship between the two media.

Organic results were somewhat different for the surface soil and sediment, particularly for pesticides/PCBs. Although these constituents were detected in sediment at low concentrations, many were non-detect in soil, indicating a source for these other than the site drainage. Concentrations of inorganics in sediment were generally at lower concentrations than those in soil, suggesting that the site may be the source for these constituents in sediment.

10.3.7.4 Soil-to-Air Transport

Three VOCs – acetone, acetonitrile, and toluene – were detected in site surface soil. However, since all concentrations were far below the soil-to-air SSLs, the pathway is not considered to be significant this site.



LEGEND

- ZONE I SEDIMENT SAMPLE LOCATION
- MONITORING WELL LOCATION
- ZONE I SOIL BORING LOCATION

12.30	ZONE I SURFACE SOIL CONC. (UG/KG)
12.30	ZONE I SUBSURFACE SOIL CONC. (UG/KG)
12.30	MAXIMUM QUARTERLY GW CONC. (UG/L)
NS	NO SAMPLE TAKEN
ND	NON DETECT

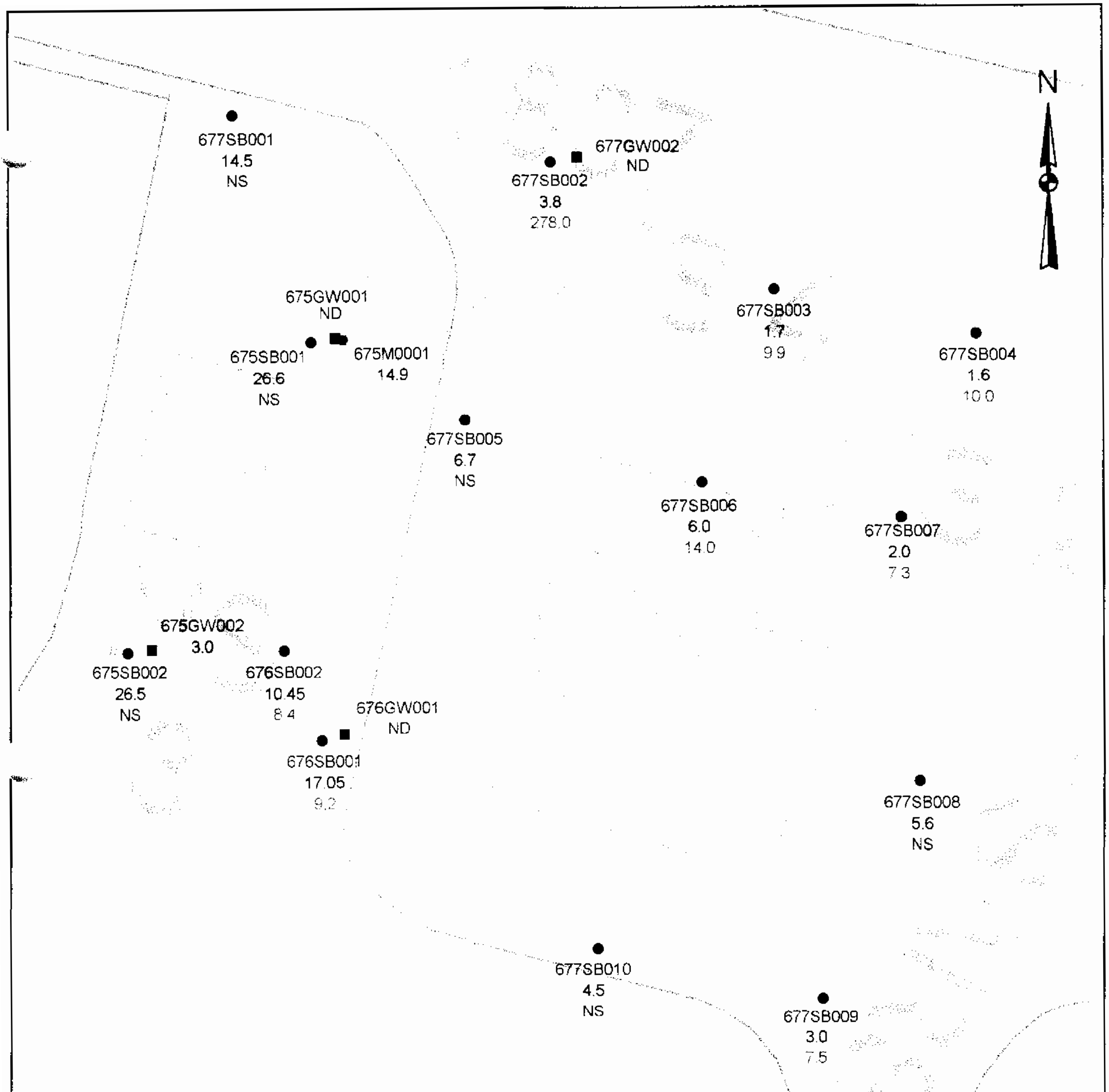
SCALE

20 0 20 40 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.3.6
ZONE I
AOC 675, 676, 677
DI-N-BUTYLPHTHALATE
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=NA RBC=780000 UG/KG SSL=2300000 UG/KG



LEGEND

●	ZONE I SEDIMENT SAMPLE LOCATION
■	MONITORING WELL LOCATION
●	ZONE I SOIL BORING LOCATION
12.30	ZONE I SURFACE SOIL CONC. (MG/KG)
12.30	ZONE I SUBSURFACE SOIL CONC. (MG/KG)
12.30	MAXIMUM QUARTERLY GW CONC. (UG/L)
NS	NO SAMPLE TAKEN
ND	NON DETECT

SCALE

20 0 20 40 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.3.7
ZONE I
AOC 675, 676, 677
COPPER
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=1300 RBC=310 MG/KG SSL=5600 MG/KG

10.3.7.5 Fate and Transport Summary

Soil-to-Groundwater Pathway

Four inorganics are present in surface and subsurface soil at levels exceeding SSLs:

- Antimony exhibited non-spatially correlated detections at low concentrations in surface and subsurface soil. It was non-detect in groundwater.
- Chromium was widely detected in surface and subsurface soils, generally at concentrations below background. It was present in groundwater, but at levels below the RBC.
- Manganese was widely detected in surface and subsurface soils, generally at concentrations below the SSL. It was present in groundwater, but at levels below background.
- Thallium was sporadically detected in surface and subsurface soil at concentrations above the SSL, with relatively higher concentrations in the subsurface soil. It was present in groundwater at a concentration above the RBC and background.

Inorganics are not expected to be associated with past site activities, primarily petroleum storage and transfer.

- The distributions of constituents, both individually and relatively, do not show remarkable trends, and suggest an origin other than the site activities.
- The inconsistent, non-spatially correlated detections of antimony and thallium, and the widespread detections of chromium and manganese, do not summarily point to the site as the source, and may be indicative of non-native fill or natural sediment composition.

The pathway is valid for chromium, manganese, and thallium, but is expected to be significant only for thallium.

Groundwater RBC and Surface Water Pathway

Thallium and manganese were the only constituents above RBC in site groundwater.

- Manganese was widely detected for four sample rounds, but never exceeded the zone-specific background.
- Thallium was detected in only one well in the fourth-round, and was non-detect for the previous rounds.
- The presence of these constituents is not unexpected given soil concentrations. Manganese can be attributed to natural occurrence, but the persistence of thallium will need to be defined with further sampling.

Di-n-butylpthalate and copper were the only constituents detected in groundwater above surface water screening values.

- The Cooper River is immediately downgradient of the site, and therefore the pathway is valid from a flow standpoint.
- Both constituents were detected in a single well and only in one round (di-n-butylpthalate in the first and copper in the second). Both have been non-detect in groundwater since, and thus the pathway is considered invalid from a chemical standpoint.

Soil-to-Sediment Pathway

Pesticide and PCB results for sediment did not correlate well with surface soil results, while inorganic results did. These relationships may indicate a secondary source for sediment contamination within the drainage system, or indicate vestiges of typical pesticide application near where the sediment sample was collected.

Soil-to-Air Pathway

Three organics were detected in surface soil but none exceeded the soil-to-air SSL, thus invalidating this pathway.

10.3.8 Human Health Risk Assessment

10.3.8.1 Site Background and Investigative Approach

The purpose of the investigation at AOCs 675/676/677 (the combined AOC) was the assessment of soil and groundwater potentially affected by past site activities. AOC 675 is a 25,000-gallon UST (Facility NS-4), installed in 1952. A 495-gallon oil/water separator is located north of this UST. This UST stored fuel oil for a boiler house (Building NS-2) built in 1958. No. 5 fuel oil was used until 1991; from 1991 on, the UST stored cleaner-burning No. 2 fuel oil. The AOC 675 area was also used to refuel seaplanes, and petroleum contamination may have resulted from this activity. Actual dates of seaplane operations are unknown, but this activity was discontinued in the mid 1950s.

Soil was sampled in one round at combined AOC 675 from the locations shown on Figure 10.3.1. The approved final RFI work plan, proposed 13 soil borings, with samples collected from the upper and lower-intervals. During the field investigation, 14 soil borings were advanced. Upper-interval samples were collected at all borings; however, only eight lower-interval samples were collected because the water table was encountered less than 5 feet bgs. All samples were analyzed for VOCs, SVOC, pesticides, PCBs, cyanide, and metals. Samples from AOC 677 were also analyzed for organotins. One upper-interval sample from AOC 677 (677SB01001) was analyzed for physical parameters. Three samples selected as duplicates were analyzed at DQO Level IV for Appendix IX analytical parameters (except that duplicate sample 677CB01001 was not analyzed for cyanide). Surface soil samples from all boring locations were used to quantitatively assess soil exposure pathways. Subsurface soil is addressed in Section 10.3.7, Fate and Transport Assessment. One sediment sample was collected in the area near the oil/water separator adjacent to Facility NS-4 and analyzed for the standard suite of parameters plus organotins, TOC and grain size analysis.

To characterize site groundwater, four shallow monitoring wells were installed and sampled. Subsurface objects and boulders prevented installation of a planned fifth well. Figure 10.3.1 illustrates monitoring well locations. Groundwater was sampled in four rounds at AOCs 675, 676, and 677. In the first round, the wells were sampled for VOCs, SVOCs, metals, cyanide, pesticides, PCBs, organotins, chloride, sulfate, and TDS at DQO Level III. Dioxins, herbicides, OP pesticides, and hexavalent chromium analyses were added to sample 67700201 to further characterize the groundwater at the site. All samples from rounds two, three, and four were analyzed for cyanides, metals, pesticides, and PCBs. Selected samples were analyzed for SVOCs, TPH-DRO/GRO, dioxins, chloride, sulfate, VOCs, and TDS. Data from the four sampling events for each well were used to quantitatively assess groundwater exposure pathways.

10.3.8.2 COPC Identification

Soil

Based on the screening comparisons described in Section 7 of this RFI and presented in Table 10.3.14, the focus of this HHRA is on the following COPCs: benzo(a)pyrene equivalents, antimony, chromium, manganese, and vanadium. Aluminum and arsenic were detected at maximum concentrations exceeding their RBCs but not exceeding their background concentrations. Therefore, these inorganics were eliminated from further consideration. Wilcoxon rank sum test analyses did not result in the inclusion of any inorganic parameters that had been screened out on the basis of background concentration comparisons.

Table 10.3.14
Chemicals Present in Site Samples
AOCs 675/676/677 - Surface Soil
Charleston Naval Complex
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration Residential RBC	Screening Concentration Background	Units	Number Exceeding RBC	Number Exceeding Background
Carcinogenic PAHs													
Benzo(a)pyrene Equivalents	*	3	14	0.047	478	161	810	980	87	NA	μG/KG	1	
Benzo(a)anthracene		2	14	41	720	381	660	800	870	NA	μG/KG		
Benzo(a)pyrene	*	1	14	330	330	330	660	800	87	NA	μG/KG	1	
Benzo(b)fluoranthene		1	14	670	670	670	770	930	870	NA	μG/KG		
Benzo(k)fluoranthene		1	14	840	840	840	620	750	8700	NA	μG/KG		
Chrysene		3	14	44	640	244	540	650	87000	NA	μG/KG		
Inorganics													
Aluminum (Al)		14	14	4310	11800	7725	NA	NA	7800	27400	MG/KG	7	
Antimony (Sb)	*	2	14	6	6.6	6.3	0.22	4.9	3.1	ND	MG/KG	2	
Arsenic (As)		5	14	3.05	5.4	4.19	1.4	9.6	0.43	21.6	MG/KG	5	
Barium (Ba)		14	14	6	25.7	17.4	NA	NA	550	54.2	MG/KG		
Beryllium (Be)		5	14	0.21	0.98	0.54	0.1	0.54	16	0.95	MG/KG		1
Cadmium (Cd)		2	14	0.53	0.72	0.625	0.06	0.53	7.8	0.61	MG/KG		1
Calcium (Ca)	N	14	14	4840	71400	28657	NA	NA	NA	NA	MG/KG		
Chromium (Cr)(total)	*	14	14	9.7	70.5	30.0	NA	NA	39	34.5	MG/KG	2	3
Chromium (Hexavalent)		1	3	0.426	0.426	0.426	0.01	0.01	39	ND	MG/KG		
Cobalt (Co)		13	14	1.4	4.4	2.31	1.4	1.4	470	5.8	MG/KG		
Copper (Cu)		14	14	1.6	26.6	9.29	NA	NA	310	240	MG/KG		
Iron (Fe)	N	14	14	2670	8870	5214	NA	NA	NA	NA	MG/KG		
Lead (Pb)		14	14	3.6	42.4	15.0	NA	NA	400	203	MG/KG		
Magnesium (Mg)	N	14	14	507	2400	1260	NA	NA	NA	NA	MG/KG		
Manganese (Mn)	*	14	14	18.8	1420	147	NA	NA	160	419	MG/KG	1	1
Mercury (Hg)		1	14	0.11	0.11	0.11	0.09	0.12	2.3	0.47	MG/KG		
Nickel (Ni)		14	14	2.7	20.9	7.45	NA	NA	160	23.9	MG/KG		
Potassium (K)	N	4	14	226	974	643	230	830	NA	NA	MG/KG		
Selenium (Se)		4	14	0.64	0.97	0.785	0.3	0.52	39	1.49	MG/KG		
Sodium (Na)	N	13	14	101	1200	410	230	230	NA	NA	MG/KG		
Thallium (Tl)		4	14	0.31	0.42	0.355	0.3	0.65	0.55	ND	MG/KG		
Tin (Sn)		3	14	1	2.4	1.73	0.93	7.4	4700	7.5	MG/KG		
Vanadium (V)	*	14	14	6.7	176	38.3	NA	NA	55	113	MG/KG	2	2
Zinc (Zn)		14	14	6.2	130	34.7	NA	NA	2300	206	MG/KG		

Table 10.3.14
Chemicals Present in Site Samples
AOCs 675/676/677 - Surface Soil
Charleston Naval Complex
Charleston, South Carolina

Parameter	Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration Residential RBC	Background	Units	Number Exceeding RBC	Background
Organotins												
Tetrabutyltin	1	9	25.3	25.3	25.3	3	4.7	2300	NA	µG/KG		
Pesticides/PCBs												
4,4'-DDD	5	14	2	34	16.2	3.8	20	2700	NA	µG/KG		
4,4'-DDE	3	14	7.3	38	18.2	3.8	20	1900	NA	µG/KG		
4,4'-DDT	2	14	4	24	14	3.8	20	1900	NA	µG/KG		
Aroclor-1260	1	14	61	61	61	22	110	320	NA	µG/KG		
beta-BHC	1	14	1.3	1.3	1.3	1.1	5.7	350	NA	µG/KG		
Chlordane	2	14	6	7.6	6.8	4.4	23	1800	NA	µG/KG		
delta-BHC	1	14	1.1	1.1	1.1	1.1	5.7	350	NA	µG/KG		
Endrin	1	14	2.8	2.8	2.8	2.7	15	2300	NA	µG/KG		
Endrin aldehyde	3	14	1.4	1.6	1.47	1.1	5.7	2300	NA	µG/KG		
gamma-BHC (Lindane)	1	14	1.2	1.2	1.2	1.1	5.7	490	NA	µG/KG		
Heptachlor epoxide	2	14	1.4	3	2.2	1.1	5.7	70	NA	µG/KG		
Semivolatile Organics												
1-Methyl naphthalene	1	14	210	210	210	1100	1300	310000	NA	µG/KG		
2-Methylnaphthalene	1	14	200	200	200	840	1000	310000	NA	µG/KG		
Acenaphthene	2	14	99	110	105	660	800	470000	NA	µG/KG		
Anthracene	1	14	110	110	110	740	900	2300000	NA	µG/KG		
bis(2-Ethylhexyl)phthalate (BEHP)	1	14	84	84	84	750	910	46000	NA	µG/KG		
Di-n-butylphthalate	1	14	35	35	35	710	900	780000	NA	µG/KG		
Fluoranthene	3	14	41	1000	364	920	1100	310000	NA	µG/KG		
Naphthalene	2	14	52	2200	1126	660	800	310000	NA	µG/KG		
Phenanthrene	1	14	55	55	55	620	750	230000	NA	µG/KG		
Pyrene	3	14	42	810	304	730	880	230000	NA	µG/KG		
Volatile Organics												
Acetone	3	14	32	72	52	23	110	780000	NA	µG/KG		
Acetonitrile	1	14	100	100	100	22	240	47000	NA	µG/KG		
Toluene	10	14	1	6	2.7	16	18	1600000	NA	µG/KG		

Table 10.3.14
Chemicals Present in Site Samples
AOCs 675/676/677 - Surface Soil
Charleston Naval Complex
Charleston, South Carolina

Parameter	Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration Residential RBC	Screening Concentration Background	Units	Number Exceeding RBC	Number Exceeding Background
TCDD Equivalents												
Dioxin (TCDD Equivalents)	3	3	1.12	2.02	1.55	NA	NA	4.3	NA	NG/KG		

Notes:
* - Indicates chemical was identified as a COPC
N - Indicates chemical is an essential nutrient
SQL - Sample quantitation limit
RBC - Risk-based concentration
μG/KG - micrograms per kilogram
MG/KG - milligrams per kilogram
NG/KG - nanograms per kilogram
NA - Not applicable or not available
ND - Not determined due to lack of information

Groundwater

As shown in Table 10.3.15, the COPCs identified in shallow groundwater for this site were thallium, dimethoate, and dibenzofuran. Wilcoxon rank sum test analyses did not result in the inclusion of any inorganic parameters that had been screened out on the basis of background concentration comparisons.

Sediment

As shown in Table 10.3.16, no COPCs were identified in sediment sampled onsite based on a comparison to residential soil RBCs and/or Zone I surface soil background concentrations.

10.3.8.3 Exposure Assessment

Exposure Setting

AOC 675 is a 25,000-gallon fuel oil storage tank (NS-4) that supports the boilers in Building NS-2. AOC 676 is a former incinerator which operated near the current location of NS-2. There is no information regarding the design, operation or demolition of this facility. AOC 677 is the grounds around Building NS-2, where there have been a number of petroleum spills associated with boiler operation. The future use of the combined AOC is unknown. Current base reuse plans indicate that the area is slated for redevelopment as a marine cargo terminal.

Potentially Exposed Populations

Potentially exposed populations are current and future site workers, hypothetical future site residents, and adolescent trespassers. Future site resident and worker exposure scenarios were addressed quantitatively in this risk assessment. The future site resident scenario was built on the premise that existing buildings would be removed and replaced with dwellings. The resident child scenario was considered to be conservatively representative of the adolescent trespasser.

Table 10.3.15
Chemicals Present in Site Samples
AOCs 675/676/677 - Shallow Groundwater
Charleston Naval Complex
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration Tap Water RBC	Background	Units	Number Exceeding RBC	Background
Inorganics													
Aluminum (Al)		2	16	28.2	29.5	28.9	18	45.6	3700	1440	µG/L		
Arsenic (As)		2	16	6.1	7.1	6.6	2.5	11.1	0.045	23	µG/L	2	
Barium (Ba)		12	16	14.8	73.4	37.2	11.4	63	260	110	µG/L		
Beryllium (Be)		4	16	0.31	0.7	0.428	0.2	1	7.3	1.1	µG/L		
Cadmium (Cd)		4	16	0.3	1.1	0.5	0.5	1	1.8	ND	µG/L		
Calcium (Ca)	N	16	16	109000	526000	225438	NA	NA	NA	NA	µG/L		
Chromium (Cr)(total)		6	16	1.1	8.6	3.48	0.8	1	18	14.3	µG/L		
Cobalt (Co)		1	16	1.2	1.2	1.2	0.6	5	220	2.2	µG/L		
Copper (Cu)		1	16	3	3	3	0.6	8.8	150	4.4	µG/L		
Iron (Fe)	N	13	16	65.8	16400	5662	20	34.2	NA	NA	µG/L		
Lead (Pb)		5	16	1.9	4	3.1	1.7	3	15	4.4	µG/L		
Magnesium (Mg)	N	16	16	14100	647000	160931	NA	NA	NA	NA	µG/L		
Manganese (Mn)		16	16	8.3	1690	309	NA	NA	73	5430	µG/L	11	
Nickel (Ni)		4	16	1.3	4.2	2.28	0.8	3.7	73	13.3	µG/L		
Potassium (K)	N	16	16	5470	324000	92917	NA	NA	NA	NA	µG/L		
Selenium (Se)		1	16	4.4	4.4	4.4	2.8	5	18	ND	µG/L		
Sodium (Na)	N	14	16	15100	5320000	1351229	500	101000	NA	NA	µG/L		
Thallium (Tl)	*	1	16	4.6	4.6	4.6	2.7	5	0.26	2	µG/L	1	1
Vanadium (V)		9	16	1.1	15.1	5.26	0.5	5.1	26	14	µG/L		1
Zinc (Zn)		2	16	4.7	10.2	7.45	4	48.8	1100	24.4	µG/L		
Herbicides													
2,4-D		1	2	0.18	0.18	0.18	2.9	2.9	6.1	NA	µG/L		
Organophosphate Pesticides													
Dimethoate	*	1	4	2	2	2	0.5	15	0.73	NA	µG/L	1	
Semivolatile Organics													
1-Methyl naphthalene		2	4	7	17	12	15	15	150	NA	µG/L		
2-Methylnaphthalene		4	11	2	5	3	10	12	150	NA	µG/L		
Acenaphthene		8	11	1	3	2.13	10	12	220	NA	µG/L		
Benzoic acid		1	11	4	4	4	50	95	15000	NA	µG/L		
Butylbenzylphthalate		1	11	12	12	12	10	12	730	NA	µG/L		
Dibenzofuran	*	5	11	1	4	2.2	10	12	2.4	NA	µG/L	2	
Di-n-butylphthalate		1	11	5	5	5	10	15	370	NA	µG/L		
Fluorene		4	11	1	8	4.75	10	12	150	NA	µG/L		

Table 10.3.15
Chemicals Present in Site Samples
AOCs 675/676/677 - Shallow Groundwater
Charleston Naval Complex
Charleston, South Carolina

Parameter	Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration Tap Water RBC	Screening Concentration Tap Water Background	Units	Number Exceeding RBC	Number Exceeding Background
Naphthalene	2	11	1	1	1	5	12	150	NA	µG/L		
Phenanthrene	3	11	2	2	2	10	15	110	NA	µG/L		
Volatile Organics												
Carbon disulfide	1	5	1	1	1	5	10	100	NA	µG/L		
TPH - GRO												
Gasoline	3	4	7.7	115	66.6	10	10	NA	NA	µG/L		
TPH - DRO												
Naphtha C6-C12	1	4	10200	10200	10200	25	1250000	NA	NA	µG/L		
TCDD Equivalents												
Dioxin	1	4	0.395	0.395	0.395	0.214	1.01	0.45	NA	PG/L		

Notes:
* - Indicates chemical was identified as a COPC
N - Indicates chemical is an essential nutrient
SQL - Sample quantitation limit
RBC - Risk-based concentration
µG/L - micrograms per liter
PG/L - picograms per liter
NA - Not applicable or not available
ND - Not determined due to lack of information

Table 10.3.16
Chemicals Present in Site Samples
AOCs 675/676/677 - Sediment
Charleston Naval Complex
Charleston, South Carolina

Parameter	Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration Residential RBC	Background	Units	Number Exceeding RBC	Background
Inorganics												
Aluminum (Al)	1	1	3190	3190	3190	NA	NA	7800	27400	MG/KG		
Antimony (Sb)	1	1	0.22	0.22	0.22	NA	NA	3.1	ND	MG/KG		
Arsenic (As)	1	1	0.52	0.52	0.52	NA	NA	0.43	21.6	MG/KG	1	
Barium (Ba)	1	1	12.4	12.4	12.4	NA	NA	550	54.2	MG/KG		
Calcium (Ca)	1	1	3460	3460	3460	NA	NA	NA	NA	MG/KG		
Chromium (Cr)	1	1	10.9	10.9	10.9	NA	NA	39	34.5	MG/KG		
Cobalt (Co)	1	1	0.63	0.63	0.63	NA	NA	470	5.8	MG/KG		
Copper (Cu)	1	1	14.9	14.9	14.9	NA	NA	310	240	MG/KG		
Iron (Fe)	1	1	3680	3680	3680	NA	NA	NA	NA	MG/KG		
Lead (Pb)	1	1	30.1	30.1	30.1	NA	NA	400	203	MG/KG		
Magnesium (Mg)	1	1	333	333	333	NA	NA	NA	NA	MG/KG		
Manganese (Mn)	1	1	23.9	23.9	23.9	NA	NA	160	419	MG/KG		
Nickel (Ni)	1	1	16.6	16.6	16.6	NA	NA	160	23.9	MG/KG		
Potassium (K)	1	1	156	156	156	NA	NA	NA	NA	MG/KG		
Sodium (Na)	1	1	276	276	276	NA	NA	NA	NA	MG/KG		
Tin (Sn)	1	1	1.9	1.9	1.9	NA	NA	4700	7.5	MG/KG		
Zinc (Zn)	1	1	66.2	66.2	66.2	NA	NA	2300	206	MG/KG		
Pesticides												
4,4'-DDD	1	1	6.5	6.5	6.5	NA	NA	2700	NA	µG/KG		
4,4'-DDE	1	1	2	2	2	NA	NA	1900	NA	µG/KG		
4,4'-DDT	1	1	2.8	2.8	2.8	NA	NA	1900	NA	µG/KG		
Aldrin	1	1	0.34	0.34	0.34	NA	NA	38	NA	µG/KG		
alpha-BHC	1	1	0.59	0.59	0.59	NA	NA	100	NA	µG/KG		
gamma-BHC	1	1	1.2	1.2	1.2	NA	NA	490	NA	µG/KG		
Dieldrin	1	1	3.7	3.7	3.7	NA	NA	40	NA	µG/KG		
Endosulfan I	1	1	12	12	12	NA	NA	47000	NA	µG/KG		
Endosulfan II	1	1	5.5	5.5	5.5	NA	NA	47000	NA	µG/KG		
Endosulfan sulfate	1	1	2	2	2	NA	NA	47000	NA	µG/KG		
Endrin	1	1	12	12	12	NA	NA	2300	NA	µG/KG		
Endrin aldehyde	1	1	8.8	8.8	8.8	NA	NA	2300	NA	µG/KG		
Heptachlor epoxide	1	1	4	4	4	NA	NA	70	NA	µG/KG		
Methoxychlor	1	1	6.6	6.6	6.6	NA	NA	39000	NA	µG/KG		
Volatile Organic												
Acetone	1	1	95	95	95	NA	NA	780000	NA	µG/KG		

Table 10.3.16
Chemicals Present in Site Samples
AOCs 675/676/677 - Sediment
Charleston Naval Complex
Charleston, South Carolina

Parameter	Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration Residential RBC	Screening Concentration Background	Units	Number Exceeding RBC	Number Exceeding Background
Semivolatile Organics												
bis(2-Ethylhexyl)phthalate (BEHP)	1	1	730	730	730	NA	NA	46000	NA	μG/KG		
Pyrene	1	1	840	840	840	NA	NA	230000	NA	μG/KG		

Notes:
* - Indicates chemical was identified as a COPC
N - Indicates chemical is an essential nutrient
SQL - Sample quantitation limit
RBC - Risk-based concentration
μG/KG - micrograms per kilogram
MG/KG - milligrams per kilogram
NG/KG - nanograms per kilogram
NA - Not applicable or not available
ND - Not determined due to lack of information

The future site worker scenario assumed continuous exposure to surface soils. Exposure for current site workers would be less than this because pavement over part of the area presents direct soil contact. Therefore, the future worker scenario is considered to be conservatively representative of current site worker.

Exposure Pathways

Exposure pathways for the hypothetical future site residents are dermal contact and incidental ingestion of surface soils. The exposure pathways for future site workers are the same with respect to soil. In addition, the future site worker scenario assumed continuous exposure to surface soil. Uniform exposure was assumed for all sample locations. The groundwater pathway for the hypothetical future site residents and site workers is incidental ingestion of groundwater. VOCs were not detected in the shallow aquifer exceeding residential RBCs, so inhalation of volatilized groundwater contaminants was not considered a viable exposure pathway. Table 10.3.17 presents the justification for assessing particular exposure pathways in this HHRA.

Exposure Point Concentrations

As discussed in Section 7 of this RFI, UCLs are generally calculated for datasets consisting of at least 10 samples. Fourteen surface soil samples were analyzed for this site. Table 10.3.18 presents the EPCs for the COPCs identified in surface soil by using the 95% UCL. Because the chromium, manganese, and vanadium UCLs did not exceed the maximum reported concentration, the UCLs for these COPCs were applied as the EPCs to estimate soil related exposures.

The maximum concentrations of benzo(a)pyrene equivalents and antimony were used as the soil pathway EPCs. The maximum concentrations of benzo(a)pyrene equivalents were used to quantify exposure using the "hot spot" approach. Benzo(a)pyrene equivalents were detected in only three of 14 surface soil samples collected, and only one (677SB006) had a concentration (478 μg/kg) within an order of magnitude of the residential RBC (87 μg/kg). This sample was collected in close proximity to the foundation of Building NS-2. As a result, it was deemed appropriate to

Table 10.3.17
AOCs 675/676/677
Exposure Pathways Summary

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Current Land Uses			
Current Users (Site Workers)	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	This exposure pathway was considered insignificant compared to the other pathways.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Shallow groundwater is not currently used as a source of potable or non-residential water at the combined AOC.
	Shallow groundwater, Inhalation of volatilized shallow groundwater contaminants	No	Shallow groundwater is not currently used as a source of potable or non-residential water at the combined AOC.
	Soil, Incidental ingestion	No (Qualified)	Future site use is considered conservatively representative of current site use.
	Soil, Dermal contact	No (Qualified)	Future site use is considered conservatively representative of current site use.
Future Land Uses			
Future Site Residents (Child and Adult), Future Site Worker	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	This exposure pathway was considered insignificant compared to the other pathways.
	Shallow groundwater, ingestion of contaminants during potable or general use	Yes	Shallow groundwater is not likely to be used as a source of potable or non-residential water at the combined AOC. This pathway was addressed as a conservative measure.
	Shallow groundwater, Inhalation of volatilized contaminants during domestic use	No	Volatile COPCs were not identified subsequent to risk-based screening comparisons.
	Soil, Incidental ingestion	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.
	Soil, Dermal contact	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.
	Wild game or domestic animals, Ingestion of tissue impacted by media contamination	No	Hunting/taking of game and/or raising livestock is prohibited within the Charleston, South Carolina city limits.
	Fruits and vegetables, Ingestion of plant tissues grown in media	No	The potential for significant exposure via this pathway is low relative to that of other exposure pathways assessed.

Table 10.3.18
Statistical Analysis of COPCs
Surface Soils
AOCs 675/676/677
Charleston Naval Complex
Charleston, South Carolina

COPC	n	Natural Log Transformed mean	SD	H-stat	UCL (mg/kg)	MAX (mg/kg)	EPC (mg/kg)	
Benzo(a)pyrene Equivalents	14	-0.325	0.048	NA	NA	0.48	0.48	MAX
Antimony (Sb)	14	0.595	1.134	3.035	8.95	6.6	6.6	MAX
Chromium (Cr)	14	3.278	0.502	2.095	40.3	70.5	40.3	UCL
Manganese (Mn)	14	4.055	1.013	2.824	213	1420	213	UCL
Vanadium (V)	14	3.104	0.993	2.789	78.6	176	78.6	UCL

Notes:

mean arithmetic mean of the logtransformed data
n number of samples analyzed
SD standard deviation for a sample of data
H-stat "H" statistic from Gilbert 1987; cuboidal interpolation was used to determine the value in accordance with *USEPA Supplemental Guidance to RAGS, Calculating the Concentration Term*
NA not applicable
EPC exposure point concentration
UCL 95 percentile upper confidence level mean
MAX maximum reported concentration

derive a fraction ingested fraction contacted (FI/FC) factor to account for the limited areal extent of the contaminant in surface soil. This factor was conservatively estimated to be 0.1, indicating that the concentration reported at 677SB006 represents soil quality over 10% of the potential exposure area. This factor was used to adjust the EPC for benzo(a)pyrene equivalents. Antimony was detected in two of 14 samples collected. Both detections of antimony were above its residential soil RBC. The maximum concentration was applied as the EPC for antimony.

Table 10.3.19 summarizes the statistical analysis for groundwater COPC data. Four shallow monitoring wells were installed at this site and sampled in four rounds. Current EPA guidance favors the use of the arithmetic mean in the most concentrated area of the plume as the EPC for groundwater COPCs. Groundwater COPCs cannot be associated with a single distinct plume. Instead, each of the COPCs were assigned to their own "plume". A separate plume is defined by the monitoring well which produced the highest concentration for a given COPC. The EPC is then calculated as the arithmetic mean of the four data points from the same well. For example, the maximum thallium detection (0.0046 mg/L) was from monitoring well 677002 during the fourth-round. The first, second, and third-round samples from this monitoring well were nondetect for thallium. The detection and one-half of the SQLs for the nondetected results yields an average of 0.003 mg/L, which was used as the EPC for thallium. The same approach was used for dibenzofuran. Dimethoate was detected in only one out of four samples (675002); the maximum concentration detected for dimethoate was used as the EPC.

Quantification of Exposure

Soil

CDIs for ingestion and dermal contact with soils are shown in Tables 10.3.20 and 10.3.21, respectively.

Table 10.3.19
Statistical Analysis of COPCs
Shallow Groundwater
AOCs 675/676/677
Charleston Naval Complex
Charleston, South Carolina

COPC	n	Natural Log Transformed mean	SD	H-stat	Mean in Plume (ug/L)	UCL (mg/L)	MAX (mg/L)	EPC (mg/L)	
Thallium (Tl)	16	-6.071	0.274	1.855	0.0030	0.0027	0.0046	0.0030	MEAN
Dibenzofuran	11	-5.716	0.668	2.423	0.0025	0.0069	0.0040	0.0025	MEAN
Dimethoate	4	NA	NA	NA	NA	NA	0.0020	0.0020	MAX

Notes:
mean arithmetic mean of the logtransformed data
n number of samples analyzed
SD standard deviation for a sample of data
H-stat "H" statistic from Gilbert 1987; cuboidal interpolation was used to determine the value in accordance with *USEPA Supplemental Guidance to RAGS, Calculating the Concentration Term*
NA not applicable
EPC exposure point concentration
UCL 95 percentile upper confidence level mean
MAX maximum reported concentration

Table 10.3.20
Chronic Daily Intakes
Incidental Ingestion of Surface Soil
AOCs 675/676/677
Charleston Naval Complex
Charleston, South Carolina

Chemical	Fraction Ingested from Contaminated Source*	Exposure Point Concentration (mg/kg)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident LWA C-CDI (mg/kg-day)	Future Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Benzo(a)pyrene Equivalents	0.1	0.48	6.55E-08	6.11E-07	7.48E-08	2.34E-08	8.35E-09
Antimony (Sb)	1	6.60	9.04E-06	8.44E-05	1.03E-05	3.23E-06	1.15E-06
Chromium (Cr)	1	40.3	5.51E-05	5.15E-04	6.30E-05	1.97E-05	7.03E-06
Manganese (Mn)	1	213	2.92E-04	2.73E-03	3.34E-04	1.04E-04	3.72E-05
Vanadium (V)	1	78.6	1.08E-04	1.01E-03	1.23E-04	3.85E-05	1.37E-05

Notes:

LWA Lifetime-weighted average; used to calculate carcinogenic CDI, *RAGS Parts A and B*
CDI Chronic daily intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
* Reflects the estimated fraction of the site impacted by the corresponding COPC.

Table 10.3.21
Chronic Daily Intakes
Dermal Contact with Surface Soil
AOCs 675/676/677
Charleston Naval Complex
Charleston, South Carolina

Chemical	Exposure Point Concentration (mg/kg)	Fraction Contacted from Contaminated Source *	Dermal Absorption Factor+	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident LWA C-CDI (mg/kg-day)	Future Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Benzo(a)pyrene Equivalents	0.48	0.1	0.01	2.68E-08	8.86E-08	1.68E-08	1.92E-08	6.85E-09
Antimony (Sb)	6.60	1	0.001	3.71E-07	1.22E-06	2.32E-07	2.65E-07	9.46E-08
Chromium (Cr)	40.3	1	0.001	2.26E-06	7.46E-06	1.42E-06	1.62E-06	5.77E-07
Manganese (Mn)	213	1	0.001	1.20E-05	3.95E-05	7.49E-06	8.55E-06	3.05E-06
Vanadium (V)	78.6	1	0.001	4.42E-06	1.46E-05	2.76E-06	3.15E-06	1.13E-06

Notes:
CDI Chronic daily intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
+ The dermal absorption factor was applied to the exposure point concentration to reflect the different trans-dermal migration of inorganic versus organic chemicals
* Reflects the estimated fraction of the site impacted by the corresponding COPC.
LWA Lifetime-weighted average; used to calculate excess carcinogenic risk derived from *RAGS Part A*

Groundwater

The CDIs for groundwater ingestion are presented in Table 10.3.22. No volatile compounds were detected in shallow groundwater, and inhalation pathway exposures were therefore not a consideration.

10.3.8.4 Toxicity Assessment

Toxicity assessment terms and methods are discussed in Section 7 of this report. Table 10.3.23 presents toxicological information specific to each COPC identified at the combine AOC. This information was used in the quantification of risk/hazard associated with soil and groundwater contaminants. Brief toxicological profiles for each COPC are provided in the following paragraphs.

Antimony is absorbed slowly through the gastrointestinal tract, which is the target of this element. Another target is the blood, where antimony concentrates. Due to frequent industrial use, the primary exposure route for antimony to the general population is ingestion. Antimony is also a common air pollutant from industrial emissions. USEPA has not classified antimony as a carcinogen, and the oral RfD is 0.0004 mg/kg-day (Klaasen, et al., 1986). The oral RfD is based on a LOAEL of 0.35 mg/kg-day, an uncertainty factor of 1,000, and a modifying factor of 1 (IRIS, 1995).

Benzo(a)pyrene equivalents include the following polynuclear aromatic hydrocarbons (PAHs):

Benzo(a)anthracene	TEF 0.1
Benzo(a)pyrene	TEF 1.0
Benzo(b)fluoranthene	TEF 0.1
Benzo(k)fluoranthene	TEF 0.01
Chrysene	TEF 0.001
Dibenz(a,h)anthracene	TEF 1.0
Indeno(1,2,3-cd)pyrene	TEF 0.1

Table 10.3.22
Chronic Daily Intakes
Ingestion/Inhalation of COPCs in Shallow Groundwater
AOCs 675/676/677
Charleston Naval Complex
Charleston, South Carolina

Chemical	Exposure Point Concentration (mg/liter)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident LWA C-CDI (mg/kg-day)	Future Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Thallium (Tl)	0.0030	8.12E-05	1.89E-04	4.46E-05	2.90E-05	1.04E-05
Dibenzofuran	0.0025	6.85E-05	1.60E-04	3.77E-05	2.45E-05	8.74E-06
Dimethoate	0.002	5.48E-05	1.28E-04	3.01E-05	1.96E-05	6.99E-06

Notes:
LWA Lifetime-weighted average
CDI Chronic daily intake
H-CDI Non-carcinogenic hazard based chronic daily intake
C-CDI Carcinogenic risk based Chronic Daily Intake

Table 10.3.23
Toxicological Reference Information
for Chemicals of Potential Concern
AOCs 675/676/677
Charleston Naval Complex
Charleston, South Carolina

	Non-Carcinogenic Toxicity Data								*Carcinogenic Toxicity Data*			
Chemical	**Oral Reference Dose (mg/kg-day)**	**Confidence Level**	**Critical Effect**	**Uncertainty Factor Oral**	**Inhalation Reference Dose (mg/kg-day)**	**Confidence Level**	**Critical Effect**	**Uncertainty Factor Inhalation**	**Oral Slope Factor (kg-day/mg)**	**Inhalation Slope Factor (kg-day/mg)**	**Weight of Evidence**	**Tumor Type**
Antimony	0.0004 a	L	whole body/blood increased mortality	1,000	NA	NA	NA	NA	NA	NA	D	NA
BEQ	NA	NA	NA	NA	NA	NA	NA	NA	7.3 a	3.1 c	B2	mutagen
Chromium III	1 a	L	NA	100/10	NA	NA	NA	NA	NA	NA a	D	NA
Chromium VI	0.005 a	L	NA	500	1E-07 c	NA	NA	NA	NA	41 a	A	lung
Dibenzofuran	0.004 c	NA	NA	NA	NA	NA	NA	NA	NA	NA	D	NA
Dimethoate	0.0002 a	M	cholinesterase inhibition	300	NA	NA	NA	NA	NA	NA	NA	NA
Manganese (food)	0.14 a	M	neurological effects	1	1.43E-05 a	M	neurological effects	1000	NA	NA	D	NA
Manganese (water)	0.023 a	M	neurological effects	1	1.43E-05 a	M	neurological effects	1000	NA	NA	D	NA
Thallium	7E-05 d	L	increased SGOT (liver) increased serum L	3000	NA	NA	NA	NA	NA	NA	D	NA
Vanadium	0.007 b	NA	unclear	100	NA	NA	NA	NA	NA	NA	D	NA

Notes:

a = Integrated Risk Information System (IRIS)
b = Health Effects Assessment Summary Tables (HEAST)
c = EPA NCEA - Cincinnati (provisional)
d = RfDo for thallium sulfate corrected for the difference in molecular weight between thallium and thallium sulfate
NA = Not applicable or not available
H = High confidence
L = Low confidence
M = Medium confidence

Some PAHs are toxic to the liver, kidney, and blood. However, the toxic effects of the above PAHs have not been well established, and there are no RfDs for these PAHs due to a lack of data. All PAHs listed above are classified by USEPA as B2 carcinogens, and their carcinogenicity is addressed relative to that of benzo(a)pyrene, which has an oral SF of 7.3 $(mg/kg\text{-}day)^{-1}$. TEFs, also set by USEPA, are multipliers applied to the detected concentrations, which are subsequently used to calculate excess cancer risk. These multipliers are discussed further in the exposure and toxicity assessment sections. Most carcinogenic PAHs have been so classified due to animal studies using large doses of purified PAHs. There is some doubt as to the validity of these listings, and the SFs listed in USEPA's RBC table are provisional. However, these PAHs are carcinogens when the exposure involves a mixture of other carcinogenic substances (e.g., coal tar, soot, or cigarette smoke). As listed in IRIS, human data that specifically link benzo(a)pyrene to a carcinogenic effect are lacking. There are, however, multiple animal studies in many species demonstrating benzo(a)pyrene to be carcinogenic by numerous routes.

Benzo(a)pyrene has produced positive results in numerous genotoxicity assays. At the June 1992 CRAVE Work Group meeting, a revised risk estimate of benzo(a)pyrene was verified. This section provides information on the aspects of the carcinogenic risk assessment for the agent in question: the USEPA classification and quantitative estimates of exposure. The classification reflects a weight-of-evidence judgment of the likelihood that the agent is a human carcinogen. The quantitative risk estimates are presented in application of a low-dose extrapolation procedure and presented as the risk per mg/kg-day. The unit risk is the quantitative estimate in terms of either risk per $\mu g/L$ drinking water or risk per $\mu g/m^3$ air breathed. The third form in which risk is presented is drinking water or air concentration providing cancer risks of 1 in 10,000 or 1 in 1,000,000. The carcinogenicity background document provides details on the carcinogenicity values found in IRIS. Users are referred to the Oral Reference Dose and Reference Concentration sections for information on long-term toxic effects other than carcinogenicity.

As listed in IRIS, the basis for the dibenz(a,h)anthracene and benzo(b)fluoranthene B2 classification is no human data and sufficient data from animal bioassays. Benzo(b)fluoranthene produced tumors in mice after lung implantation, intraperitoneal or subcutaneous injection, and skin painting. As listed in IRIS, the basis for the benzo(a)anthracene B2 classification is no human data and sufficient data from animal bioassays. Benzo(a)anthracene produced tumors in mice exposed by gavage; intraperitoneal, subcutaneous or intramuscular injection; and topical application. Benzo(a)anthracene produced mutations in bacteria and in mammalian cells, and transformed mammalian cells in culture. As listed in IRIS, the basis for the benzo(k)fluoranthene B2 classification is no human data and sufficient data from animal bioassays. Benzo(k)fluoranthene produced tumors after lung implantation in mice and when administered with a promoting agent in skin-painting studies. Equivocal results have been found in a lung adenoma assay in mice. Benzo(k)fluoranthene is mutagenic in bacteria. (Klaasen, et al., 1986).

Chromium exists in two stable, natural forms: CrIII and hexavalent CrVI. Acute exposure to chromium can result in kidney damage following oral exposure, or damage to the nasal mucosa and septum following inhalation exposure. Chronic inhalation exposure to CrVI has resulted in kidney and respiratory tract damage, as well as excess lung cancer in both animals and humans following occupational exposure. Only CrVI is believed to be carcinogenic by inhalation (IRIS). Oral RfD values for CrIII and CrVI are 1.0 and 5E-03 (mg/kg-day), respectively. For CrVI, the RfD is based on liver toxicity in rats. For CrVI, the RfD is based on unspecified pathological changes observed in rat studies. In addition, CrVI is considered a group A carcinogen for inhalation exposures, and an inhalation SF of 41 $(mg/kg\text{-}day)^{-1}$ has been established for the hexavalent form. Vitamin supplements contain approximately 0.025 mg of chromium. As listed in IRIS, no critical effects were observed for CrIII. The uncertainty factor was 100 and the modifying factor was 10. As listed in IRIS, no critical effects were observed for CrVI. The uncertainty factor was 500 and the modifying factor was 1.

Dibenzofuran, an organic compound similar in structure to some PAHs, is toxic to the liver and kidneys. In addition, this compound can accumulate in fatty tissue. USEPA has not determined an SF for this compound, but has set a provisional RfD of 0.004 mg/kg-day.

Dimethoate, otherwise known as ***Cyton***, is an organophosphorous pesticide which causes neurological effects. A typical effect of chronic overexposure is delayed neuropathy; other effects associated with acute exposure include gastrointestinal disturbances and effects on the heart and other organ muscles. Although this compound does not accumulate in the body, the delayed effects of chronic exposure can accumulate to produce acute-like signs of organophosphate pesticide exposure (Klaasen, et al., 1986). The critical effect listed in IRIS is cholinesterase inhibition. The uncertainty factor of 300 and modifying factor of 1 were used by USEPA to determine the oral RfD of 2E-04 mg/kg-day. As listed in IRIS, the confidence in the oral RfD is medium.

Manganese is an essential nutrient, but chronic exposure (0.8 mg/kg-day) causes mental disturbances. Studies have shown that manganese uptake from water is greater than manganese uptake from food, and the elderly appear to be more sensitive than children (Klaasen et al., 1986; Dreisbach et al., 1987). USEPA determined the RfD to be 0.14 mg/kg-day based on dietary uptake. USEPA recommended using a modifying factor of 3 when estimating intake from soil and water. In addition, the body absorbs roughly twice as much manganese in water as it does manganese in food. Because of the different uptake rates in water and food, two RfDs were used in this HHRA — one for water and one for food. The RfDs used are 0.047 and 0.023 mg/kg-day, respectively. Inhalation of manganese dust causes neurological effects and increased incidence of pneumonia. An inhalation RfD was set to 1.43E-05 mg/kg-day. According to USEPA, manganese cannot be classified as to its carcinogenicity. Therefore, its cancer class is group D. As listed in IRIS, this classification is based on studies that are inadequate to assess the carcinogenicity of manganese. Manganese is considered essential to human health; the typical vitamin supplement dose is 2.5 mg/day. As listed in IRIS, the critical effects of this chemical in water in the oral summary are CNS effects. The uncertainty factor was 1 and the recommended modifying factor of 3 was used to estimate soil and groundwater intake. As listed in IRIS, the critical effect of manganese in the inhalation summary is neuro-behavioral impairment. For inhalation uptake, the uncertainty factor was 1,000 and the modifying factor was 1. The IRIS RfC is 5E-05 mg/m^3.

Thallium is readily absorbed through the gut and skin. Primary effects are stomach and bowel disturbances, kidney and liver damage, and neurological disturbances. Thallium was used in the past as a rodenticide and ant killer, uses now prohibited. This element remains in the body for a relatively long time and could accumulate if the chronic dose is large. USEPA's oral RfD for thallium is 8E-05 mg/kg-day (Klaasen, et al., 1986; Dreisbach, et al., 1987). The uncertainty factor used for thallium is 3,000.

Vanadium is not readily absorbed through the skin or via oral ingestion, and is a ubiquitous element. It is also a by-product of petroleum refining. Vanadium is soluble in fats and oils (Klaasen et al., 1986). Municipal water supplies contain 0.001 to 0.006 mg/L. The target organ is unclear, and the primary focus of toxicological information is inhalation of vanadium dust. Vitamin supplements contain approximately 0.010 mg in a daily dose. The oral RfD set by USEPA is 0.007 mg/kg-day. The uncertainty factor used for vanadium is 100.

10.3.8.5 Risk Characterization

Surface Soil Pathways

Exposure to surface soil was evaluated under both residential and industrial (site worker) scenarios. For these scenarios, the incidental ingestion and dermal contact exposure pathways were evaluated. For noncarcinogenic contaminants evaluated for future site residents, hazard was computed separately to address child and adult exposures. Tables 10.3.24 and 10.3.25 present the computed carcinogenic risks and/or HQs associated with the incidental ingestion of and dermal contact with site surface soils, respectively.

Table 10.3.24
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
AOCs 675/676/677
Charleston Naval Complex
Charleston, South Carolina

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used $(mg/kg\text{-}day)^{-1}$	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident LWA ILCR	Future Worker adult Hazard Quotient	Future Worker adult ILCR
Benzo(a)pyrene Equivalent	NA	7.3	ND	ND	5.5E-07	ND	6.1E-08
Antimony (Sb)	0.0004	NA	0.023	0.21	ND	0.0081	ND
Chromium (Cr)	0.005	NA	0.011	0.10	ND	0.0039	ND
Manganese (Mn)	0.14	NA	0.0021	0.019	ND	0.0007	ND
Vanadium (V)	0.007	NA	0.015	0.14	ND	0.0055	ND
SUM Hazard Index/ILCR			0.05	0.5	5E-07	0.02	6E-08

Notes:
NA Not available
ND Not determined due to lack of available information
LWA Lifetime-weighted average; used to calculate excess carcinogenic risk derived from *RAGS Part A*.
ILCR Incremental lifetime excess cancer risk

Table 10.3.25
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
AOCs 675/676/677
Charleston Naval Complex
Charleston, South Carolina

Chemical	Dermal Adjustment	Oral RfD Used (mg/kg-day)	Oral SF Used $(mg/kg\text{-}day)^{-1}$	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident LWA ILCR	Future Worker adult Hazard Quotient	Future Worker adult ILCR
Benzo(a)pyrene Equivalents	0.5	ND	14.6	ND	ND	2.5E-07	ND	1.0E-07
Antimony (Sb)	0.2	8E-05	ND	0.0046	0.015	ND	0.0033	ND
Chromium (Cr)	0.2	0.001	ND	0.0023	0.0075	ND	0.0016	ND
Manganese (Mn)	0.2	0.028	ND	0.00043	0.0014	ND	0.00031	ND
Vanadium (V)	0.2	0.0014	ND	0.0032	0.010	ND	0.0023	ND
SUM Hazard Index/ILCR				0.010	0.03	2E-07	0.007	1E-07

Notes:
NA Not available
ND Not determined due to lack of available information
LWA Lifetime-weighted average; used to calculate excess carcinogenic risk derived from *RAGS Part A*
ILCR Incremental Lifetime excess Cancer Risk
- Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)

Hypothetical Site Residents

The ingestion ILCR (based on the adult and child lifetime-weighted average) for the combined AOC surface soils is 5E-07. The dermal pathway ILCR is 2E-07. Benzo(a)pyrene equivalents were the sole contributor for each pathway.

The computed hazard indices for the adult resident were less than 0.1 for the soil ingestion and dermal contact pathways. The computed hazard indices for the child ingestion and dermal contact pathways were 0.5 and 0.03, respectively.

Future Site Workers

Site worker ILCRs are 6E-08 and 1E-07 for the ingestion and dermal contact pathways, respectively. Hazard indices for the ingestion and dermal pathways were both projected to be less than 0.1 for the future site worker scenario.

The AOCs 675/676/677 area is an asphalt parking lot and grassy area near Building NS-2. Current site users have little chance of exposure to affected surface soil. Location 677SB006, the source of the maximum benzo(a)pyrene equivalent concentrations is beneath an asphalt surface. Should the existing pavement remain under future use scenarios, the risk/hazard projections presented above would be gross overestimates.

Groundwater Pathways

Exposure to shallow groundwater was evaluated under both residential and industrial scenarios. The ingestion exposure pathway was evaluated assuming that site groundwater will be used for potable and/or domestic purposes and that an unfiltered well, drawing from the corresponding water-bearing zone, will be installed. For noncarcinogenic contaminants evaluated relative to future site residents, hazard was computed separately for child and adult receptors. Table 10.3.26

Table 10.3.26
Hazard Quotients and Incremental Lifetime Cancer Risks
Shallow Groundwater Ingestion
AOCs 675/676/677
Charleston Naval Complex
Charleston, South Carolina

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used $(mg/kg\text{-}day)^{-1}$	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident LWA ILCR	Future Worker adult Hazard Quotient	Future Worker adult ILCR
Thallium (Tl)	0.00007	NA	1.2	2.7	ND	0.414	ND
Dibenzofuran	0.004	NA	0.017	0.040	ND	0.0061	ND
Dimethoate	0.0002	NA	0.27	0.64	ND	0.098	ND
SUM Hazard Index/ILCR			1	3	ND	0.5	ND

Notes:

NA Not available
ND Not determined due to lack of available information
lwa Lifetime-weighted average; used to calculate excess carcinogenic risk derived from *RAGS Part A*
ILCR Incremental lifetime excess cancer risk

presents the risk and hazard for the exposure pathway. Since no VOCs were identified as COPCs in groundwater at the combined AOCs, the inhalation pathway was not addressed at this site.

Hypothetical Site Residents

For the ingestion pathway, the hazard indices for the adult and child resident are 1 and 3, respectively. The primary contributor to hazard indices for the groundwater ingestion pathway was thallium. No carcinogenic COPCs were identified in shallow groundwater; thus, no ILCR projections were made.

Future Site Workers

The hazard index for the ingestion exposure pathway was calculated to be 0.5. No carcinogenic COPCs were identified in shallow groundwater, and thus no ILCR projections were made.

Current Site Workers

Shallow groundwater is not currently used as a potable water source for the combined AOCs or other areas of Zone I. In the absence of a completed exposure pathway, no threat to human health is posed by reported shallow groundwater contamination.

COCs Identified

USEPA has established a generally acceptable risk range of 1E-04 to 1E-06, and a hazard index threshold of 1.0 (unity). As recommended by SCDHEC, a COC was considered to be any chemical contributing to a cumulative risk level of 1E-06 or greater and/or a cumulative hazard index above 1.0, and whose individual ILCR exceeds 1E-06 or whose hazard quotient exceeds 0.1. For carcinogens, this approach is relatively conservative, because a cumulative risk level of 1E-04 (and individual ILCR of 1E-06) is recommended by USEPA Region IV as the trigger for establishing COCs. The specified COC selection method was used in order to provide a more comprehensive evaluation of chemicals contributing to carcinogenic risk or noncarcinogenic hazard during the development of remedial goal options. Table 10.3.27 presents the COCs identified for the combined AOCs surface soil and groundwater.

Surface Soils

Hypothetical Site Residents (future land use)

No COCs were identified for this scenario based on the sum ILCR and hazard index.

Future Site Workers (current land use)

No COCs were identified for this scenario based on the sum ILCR and hazard index.

Groundwater

Future Site Residents

Thallium and dimethoate were identified as groundwater pathway COCs based on their contribution to cumulative residential HI projections. Thallium was detected at a concentration exceeding its tap-water RBC (0.26 μg/L) in one fourth-quarter groundwater sample (677002). Thallium also exceeded its MCL (2 μg/L) in the fourth-quarter sample. Dimethoate was detected at a concentration exceeding its tap-water RBC (0.73 μg/L) in one first-quarter groundwater sample (675002).

Future Site Workers

No COCs were identified for this scenario based on cumulative industrial ILCR and HI projections.

10.3.8.6 Risk Uncertainty

Characterization of Exposure Setting and Identification of Exposure Pathways

The potential for high bias in exposure assessment is introduced through exposure setting and pathway selection due to the highly conservative assumptions (i.e., future residential use)

Table 10.3.27
Summary of Risk and Hazard-based COCs
AOCs 675/676/677
Charleston Naval Complex
Charleston, South Carolina

Medium	Exposure Pathway		Future Resident Adult Hazard Quotient	Future Resident Child Hazard Quotient	Future Resident LWA ILCR	Future Site Worker Hazard Quotient	Future Site Worker ILCR	Identification of COCs
Surface Soil	Incidental Ingestion	Benzo(a)pyrene Equivalents	ND	ND	5.5E-07	ND	6.1E-08	
		Antimony (Sb)	0.023	0.21	ND	0.0081	ND	
		Chromium (Cr)	0.011	0.10	ND	0.0039	ND	
		Manganese (Mn)	0.0021	0.019	ND	0.0007	ND	
		Vanadium (V)	0.015	0.14	ND	0.0055	ND	
	Dermal Contact	Benzo(a)pyrene Equivalents	ND	ND	2.5E-07	ND	1.0E-07	
		Antimony (Sb)	0.0046	0.015	ND	0.0033	ND	
		Chromium (Cr)	0.0023	0.0075	ND	0.0016	ND	
		Manganese (Mn)	0.00043	0.0014	ND	0.00031	ND	
		Vanadium (V)	0.0032	0.010	ND	0.0023	ND	
Surface Soil Pathway Sum			0.06	0.5	8E-07	0.03	2E-07	
Shallow Groundwater	Ingestion	Thallium (Tl)	1.2	2.7	ND	0.41	ND	1
		Dibenzofuran	0.017	0.040	ND	0.0061	ND	
		Dimethoate	0.27	0.64	ND	0.098	ND	1
Shallow Groundwater Pathway Sum			1	3	ND	0.5	ND	
Sum of All Pathways			2	4	8E-07	0.5	2E-07	

Notes:
ND = not determined due to the lack of available risk information.
ILCR = incremental excess lifetime cancer risk
HI = hazard index
LWA = Lifetime-weighted average
1- Chemical is a COC by virtue of projected child residence non-carcinogenic hazard.

recommended by USEPA Region IV. The exposure assumptions made in the site worker scenario are highly conservative and would tend to overestimate exposure. The area found to be impacted by COPCs is covered by asphalt, precluding exposure to affected surface soil. Also, current site workers are not exposed to site groundwater.

Residential use of the site is not expected or likely, based on current site uses and the nature of surrounding buildings. Current reuse plans call for continued commercial/industrial use of Zone I, specifically as a marine cargo terminal. If this area were to be used as a residential site, the buildings would be demolished, asphalt surface removed, and the surface soil conditions would likely change. For example, the soils would be covered with landscaping soil and/or a house. Consequently, exposure to current surface soil conditions would not be likely under a true future residential scenario. These factors indicate that exposure pathways assessed in this HHRA generally overestimate the risk and hazard posed to current site workers and future site residents.

Shallow groundwater is not currently used at the combined AOCs for potable or industrial purposes. A basewide system provides drinking and process water to buildings throughout Zone I. This system is slated to remain in operation under the current base reuse plan, and shallow groundwater is not expected to be used under future site use scenarios. Therefore, the scenario established to project risk/hazard associated with shallow groundwater exposure is highly conservative.

Determination of Exposure Point Concentrations

Exposure point concentrations (EPCs) for soil were set equal to either the 95% UCL or the maximum concentration calculated on the combined AOC dataset. This represents a conservative approach. The maximum concentration of benzo(a)pyrene equivalents was applied as its EPC, which was then modified in accordance with the "hot spot" approach.

The 95% UCLs or arithmetic means of the detected concentrations were applied as the EPC for groundwater. USEPA Region IV guidance states that the average concentration of each COPC in the most concentrated area of the plume should be used as the EPC. Since a plume cannot be readily defined, this guidance applies only marginally. This spatial variability in groundwater data contributes greatly to uncertainty. The 95% UCLs were calculated to provide point estimates to account for this uncertainty, thus providing an upper bound estimate for modeling exposure. For any given COPC, the placement of monitoring wells in uncontaminated areas of the aquifer could cause a low bias on the 95% UCL. As a result, the arithmetic mean of detected concentrations was compared to the 95% UCL, and the greater of the two was selected as the EPC. To address uncertainty resulting from the selection of EPCs and to provide additional perspective, risk/hazard maps may be referenced in the Risk Summary Section.

Frequency of Detection and Spatial Distribution

Surface Soil

Benzo(a)pyrene equivalents were detected in only three of 14 surface soil samples collected, and only one (677SB006) had a concentration (0.478 mg/kg) within an order of magnitude of the residential RBC. This sample was collected in close proximity to the foundation of Building NS-2. As a result, it was deemed appropriate to derive an FI/FC to account for the limited areal extent of the contaminant in surface soil. This factor was conservatively estimated to be 0.1, indicating that the concentration reported at 677SB006 represented soil quality over 10% of the potential exposure area. The FI/FC factor was used to adjust the EPC for benzo(a)pyrene equivalents. The fraction ingested from contaminated sources (based on the spatial distribution and frequency of detection for each COPC) was considered in the exposure calculations at the combined AOCs. Additional sampling in the vicinity of reportedly impacted surface soils could serve to further reduce the FI/FC factor and exposure estimates.

Antimony was detected in two of 14 surface soil samples collected, (677SB006 and 677SB010) and both slightly exceeded the residential RBC. Chromium, manganese, and vanadium were detected in most of the surface soil samples collected from the combined AOCs and each exceeded their background concentrations in a few samples.

Groundwater

Dimethoate was detected in only one of the four shallow monitoring wells (675002) at a concentration exceeding its tap-water RBC. Dibenzofuran was detected in five of 11 shallow groundwater samples collected; it exceeded the tap-water RBC in the second and third-quarter samples from monitoring well 675002. The only detection of thallium was in the fourth-quarter sampling of monitoring well 677002, where it exceeded its tap-water RBC and background concentration.

Quantification of Risk/Hazard

Many site-specific factors affect the uncertainty of this assessment and cause upward bias in the risk and hazard estimates. Exposure pathway-specific sources of uncertainty are discussed below.

Soil

Of the CPSSs screened and eliminated from formal assessment, none was reported at a concentration close to its corresponding RBC (i.e., within approximately 10% of the RBC). This minimizes the likelihood of potentially significant cumulative risk/hazard based on the eliminated CPSSs. Aluminum and arsenic exceeded their corresponding RBCs, but they were eliminated from formal assessment because they did not exceed their background concentrations.

Although the future land use of the combined AOCs is unknown, both the worker and residential exposure scenarios were assessed in this HHRA. As previously discussed, it is likely that these scenarios overestimate risk and/or hazard.

Groundwater

Of the CPSSs screened and eliminated from formal assessment, arsenic and manganese were reported at concentrations exceeding their corresponding RBCs but well below their background concentrations.

Groundwater is not currently used as a potable water source at the combined AOCs or in the surrounding area. Municipal water is readily available. It is highly unlikely that the site will be developed as a residential area or that a potable-use well would be installed onsite. If residences were constructed onsite and an unfiltered well were installed, the salinity and dissolved solids would likely preclude this aquifer from being an acceptable potable water source.

Background-Related Risk

Soil

Aluminum and arsenic were detected in surface soil at concentrations above their respective RBCs. These elements were eliminated from consideration in the risk assessment based on comparison to background values. It is not unusual for naturally occurring or background concentrations of some elements to exceed risk-based concentrations. The following addresses risk/hazard associated with background concentrations of aluminum and arsenic.

The maximum surface soil concentration of aluminum (11,800 mg/kg) for the combined AOCs equates with hazard quotients of 0.2 and 0.01 for the resident child and site worker, respectively. The background value for aluminum (27,400 mg/kg) results in hazard quotients of 0.4 and 0.02 for the resident child and site worker, respectively. The maximum surface soil concentration of arsenic (5.4 mg/kg) and equates with ILCRs of 1E-05 and 2E-06 for the residential and site worker scenarios, respectively, equates with hazard quotients of 0.3 and 0.01 for the resident child and site worker, respectively. The background value for arsenic (21.6 mg/kg) equates with ILCRs of 6E-05 and 8E-06 and hazard quotients of 0.1 and 0.05 for the resident and site worker scenarios, respectively.

Groundwater

Arsenic and manganese were detected in groundwater samples at concentrations exceeding their respective RBCs. These inorganics were eliminated from consideration in the risk assessment based on comparison to background values. The following addresses the risk/hazard associated with background concentrations of arsenic and manganese.

The maximum groundwater concentration of arsenic (7.1 μg/L) for the combined AOCs equates with ILCRs of 2E-04 and 7E-05 and hazard quotients of 2 and 0.5 for the resident child and site worker, respectively. The background value for arsenic (23 μg/L) equates with ILCRs of 5E-04 and 2E-04 and hazard quotients of 5 and 2, respectively, for the resident child and site worker. The maximum reported concentration of manganese (1,690 μg/L) yielded hazard quotients of 2 and 1 for the resident and site worker scenarios, respectively. Hazard quotients resulting from the background value for manganese (5,430 μg/L) were 7 and 5 for the residential child and site worker, respectively.

10.3.8.7 Risk Summary

The risk and hazard posed by contaminants at the combined AOCs were assessed for the future site worker and future site resident under reasonable maximum exposure assumptions. This HHRA assessed the incidental ingestion and dermal contact pathways for surface soils. The ingestion pathway was evaluated for shallow groundwater, based on four quarters of groundwater monitoring data. Table 10.3.28 presents the risk summary for each pathway/receptor group evaluated.

Table 10.3.28
Summary of Risk and Hazard
AOCs 675/676/677
Charleston Naval Complex
Charleston, South Carolina

Medium	Exposure Pathway	HI Resident (Adult)	HI Resdient (Child)	ILCR Resident (LWA)	HI (Worker)	ILCR (Worker)
Surface Soil	Incidental Ingestion	0.05	0.5	5E-07	0.02	6E-08
	Summary of Risk and Hazard					
	Dermal Contact	0.01	0.03	2E-07	0.007	1E-07
Shallow Groundwater	Ingestion	1	3	ND	0.5	ND
Sum of All Pathways		2	4	8E-07	0.5	2E-07

Notes:
ND = not determined due to the lack of available risk information.
ILCR = incremental excess lifetime cancer risk
HI = hazard index
LWA = Lifetime-weighted average

Soil — Residential Scenario

No residential soil pathway COCs were identified.

Soil — Site Worker Scenario

No industrial soil pathway COCs were identified.

Groundwater — Residential Scenario

Dimethoate and thallium were identified as groundwater pathway COCs. Table 10.3.29 provides point hazard estimates for the combined AOCs groundwater. As shown, thallium was the primary contributor to hazard estimates. Figure 10.3.8 shows point hazard estimates for groundwater for the residential scenario. Hazard estimates ranged from 0.02 (67500101) to 4 (67700204), with a mean hazard index of 0.3.

Groundwater — Industrial Scenario

No COCs were identified for groundwater based on the site worker scenario.

10.3.8.8 Remedial Goal Options

Soil

No RGOs were computed for the combined AOCs surface soil, as no COCs were identified.

Groundwater

Groundwater RGOs based on the site resident scenario are shown in Table 10.3.30.

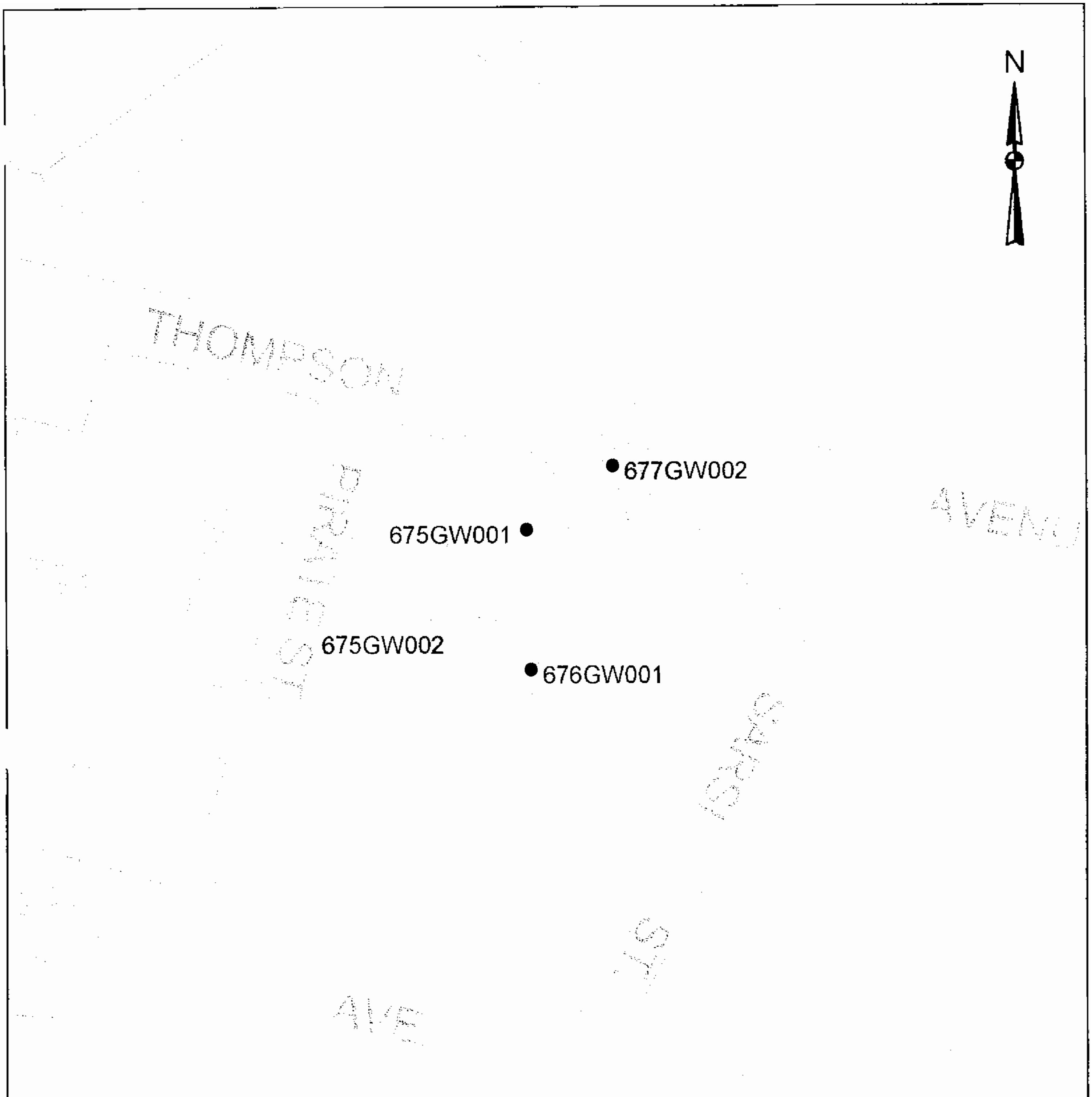
Table 10.3.29
Point Estimates of Risk and Hazard - Groundwater Pathways
Residential Scenario
AOCs 675/676/677
Charleston Naval Complex
Charleston, South Carolina

AOC	Location	Round	Parameter	Concentration	Units	Hazard Index	Risk (E-06)
675	001	01	Dibenzofuran	1	µG/L	0.016	NA
					Total	0.016	NA
675	001	02	No COPCs			NA	NA
675	001	03	No COPCs			NA	NA
675	001	04	No COPCs			NA	NA
675	002	01	Dibenzofuran	1	µG/L	0.016	NA
675	002	01	Dimethoate	2	µG/L	0.639	NA
					Total	0.655	NA
675	002	02	Dibenzofuran	3	µG/L	0.048	NA
					Total	0.048	NA
675	002	03	Dibenzofuran	4	µG/L	0.064	NA
					Total	0.064	NA
675	002	04	Dibenzofuran	2	µG/L	0.032	NA
					Total	0.032	NA
676	001	01	No COPCs			NA	NA
676	001	02	No COPCs			NA	NA
676	001	03	No COPCs			NA	NA
676	001	04	No COPCs			NA	NA
677	002	01	No COPCs			NA	NA
677	002	02	No COPCs			NA	NA
677	002	03	No COPCs			NA	NA
677	002	04	Thallium (Tl)	4.6	µG/L	3.676	NA
					Total	3.676	NA

Table 10.3.30
Residential-Based Remedial Goal Options Shallow Groundwater
AOCs 675/676/677
Charleston Naval Complex
Charleston, South Carolina

Chemical	Oral SF (mg/kg-day)-1	Oral RfD (mg/kg-day)	EPC mg/L	Hazard-Based Remedial Goal Options 0.1 mg/L	1.0 mg/L	3 mg/L	Risk-Based Remedial Goal Options 1E-06 mg/L	1E-05 mg/L	1E-04 mg/L	MCL mg/L	Background Concentration mg/L
Dimethoate	NA	0.0002	0.002	0.00031	0.0031	0.0094	ND	ND	ND	NA	NA
Thallium (Tl)	NA	7E-05	0.0030	0.00011	0.0011	0.0033	ND	ND	ND	0.002	0.002

Notes:
EPC exposure point concentration
NA not applicable
ND not determined
- remedial goal options were based on the resident lifetime-weighted average for carcinogens and the child resident for noncarcinogens



LEGEND

- NO COPCs
- < 1E-6
- 1E-6 to 5E-6
- 5E-6 to 1E-5
- 1E-5 to 1E-4
- > 1E-4

70 0 70 140 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.3.8
ZONE I
AOCs 675, 676 & 677

SURFACE SOIL POINT RISK
RESIDENTIAL SCENARIO

10.3.9 Corrective Measures Considerations

Based on the analytical results and the human health risk assessment for AOCs 675/676/677, COCs requiring further evaluation through the CMS process have been identified for surface soil and groundwater. The site is in a moderately developed urban setting and risk to human health was evaluated under both residential and industrial (site worker) scenarios. For these scenarios, the incidental ingestion and dermal contact exposure pathways were evaluated. Hazard was evaluated for noncarcinogenic contaminants through incidental ingestion and dermal contact as well.

As recommended by SCDHEC, a COC is considered to be any chemical contributing to a cumulative risk level of 1E-06 or greater and/or a cumulative hazard index above 1.0, and whose individual risk exceeds 1E-06 or whose hazard quotient exceeds 0.1.

No residential soil pathway COCs were identified for AOCs 675/676/677. Thallium and dimethoate were identified as groundwater COCs. Table 10.3.31 presents cumulative and COC specific exposure risks and hazard quotients.

Risk-based remedial goals for shallow groundwater are presented in Table 10.3.30. Potential corrective measures for soil are presented in Table 10.3.32.

Table 10.3.31
AOCs 675/676/677
Cumulative and Chemical-Specific Exposure Risks and Hazard

Chemical	Risk: Industrial	Risk: Residential	Hazard: Industrial	Hazard: Residential
Groundwater				
Thallium	ND	ND	0.41	2.7
Dimethoate	ND	ND	0.098	0.64
Cumulative	ND	ND	0.5	3.34

Note:
ND = Not detected

Table 10.3.32
AOCs 675/676/677
Potential Corrective Measures

Medium	Compounds	Potential Corrective Measures
Groundwater	Thallium, Dimethoate	a) No action b) Monitoring c) Ex-situ physical/chemical treatment and discharge to POTW d) Ex-situ physical/chemical treatment and discharge through NPDES permitting

10.4 AOCs 678, Firefighter School, Former Building 2-V, and AOC 679, Former Wash Rack

AOC 678 is the former site of Building 2-V, the Firefighter School, northeast of Building NS-1 in the northeastern portion of the southern peninsula. The firefighting school was reportedly constructed in 1947 and demolished circa 1955. Controlled fires may have been ignited and extinguished onsite for firefighter training. No other details regarding the design features or operating practices were available. Currently, the area is a paved parking lot.

AOC 679 consists of a former wash rack noted on early CNC maps from the 1930s and 1940s. This former wash rack was located off the west edge of Building NS-1. No information is available regarding the design features, years of operation, or operating practices for the wash rack. It is assumed that activities at this unit included washing or cleaning of equipment in an external wash area.

Materials of concern at AOC 678/679 include petroleum hydrocarbons, VOCs, used oil, and grease. Currently, the paved parking lot is rarely used, therefore, potential receptors include workers that may be involved in invasive activities at the site. The ecology of the Cooper River is also a potential receptor.

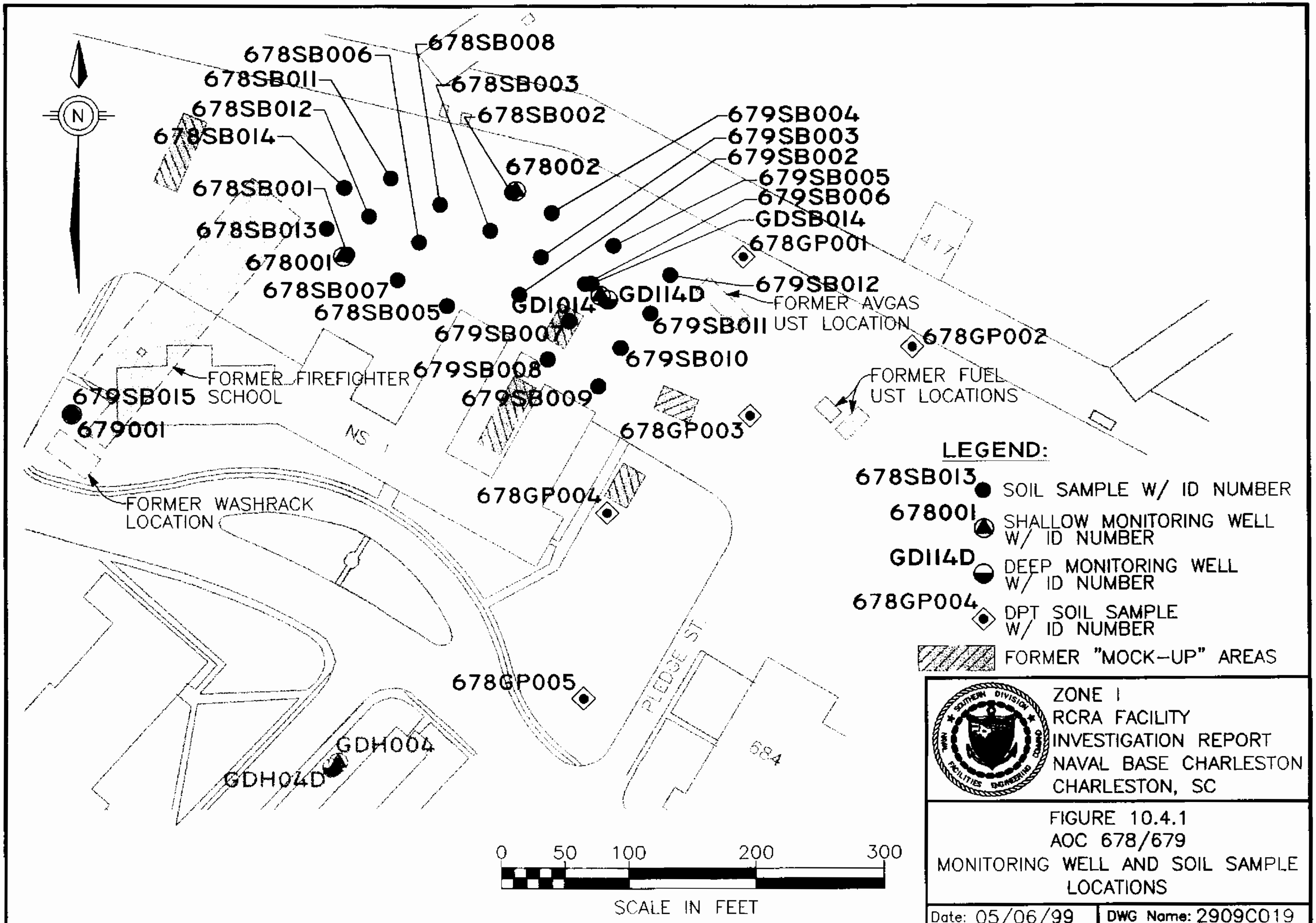
Soil and groundwater were sampled in accordance with the *Final Zone I RFI Work Plan*, (E/A&H, February 1995) and Section 3 of this report to fulfill CSI objectives. In March 1999, five geoprobe samples were collected on the eastern edge of AOC 678/679 at areas that were thought to correspond to former locations of "mock ups" for the old firefighter training area. An additional well/boring was located in the area of the former wash rack on September 1998.

10.4.1 Soil Sampling and Analysis

Soil was sampled in three rounds at AOC 678/679 from the locations shown on Figure 10.4.1. The *Final Zone I RFI Work Plan* (E/A&H, 1995) proposed collecting 25 samples from the upper interval and 25 samples from the lower interval. During the first round, 21 samples were collected from the upper interval. Four of the 25 proposed upper interval samples were inaccessible due to structural barriers. Thirteen of the 25 proposed lower interval samples were not collected due to a water table less than 5 feet bgs; saturated samples were not submitted for analysis. All samples were submitted for the standard suite of parameters which include VOCs, SVOCs, pesticides, PCBs, cyanide, and metals. Three samples were duplicated and submitted for Appendix IX analytical parameters at DQO Level IV, which include the standard suite of parameters and a more comprehensive list of VOCs, SVOCs, and herbicides, hexavalent chromium, organophosphate pesticides, and dioxins.

Second-round sampling was performed after first-round analytical results were compared to the USEPA Region III *Risk-Based Concentration Table*, March 1995, and background screening values. This comparison showed that soil boring location 678SB012 had detections of mercury and lead above RBCs and background, justifying the collection of two additional samples for inorganic analysis. The third round sample was collected from the well boring installed in the areas of the former wash rack for VOCs, SVOCs, and metals. Table 10.4.1 summarizes soil sampling at AOC 678 and AOC 679.

Grid-based soil boring (GDISB014) was advanced in the AOC 678/679 area as shown in Figure 10.4.1. Upper and lower-interval samples from this boring were analyzed for the standard suite of parameters. Results of these analyses are presented in the nature and extent discussion of AOC 678/679.



ZONE I
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.4.1
AOC 678/679
MONITORING WELL AND SOIL SAMPLE LOCATIONS

Date: 05/06/99 | DWG Name: 2909C019

Table 10.4.1
AOC 678/679
Soil Sampling Summary

Sampling Round	Sampling Date	Samples Collected	Sample Analyses	Comments
1	02/22/95 03/01/95 03/06/95	Upper - 21 (25)	Standard Suite, Additional Parameters[a]	Four sample locations were inaccessible. 678SB00901 sampled for organotins only.
	03/10/95 03/13/95	Lower - 12 (25)	Standard Suite	Thirteen lower samples were not collected due to a water table less than 5 feet bgs.
		Duplicates - 3	Appendix IX[b]	
2	06/21/95	Upper - 2	Metals	To delineate the extent of metals detected above their RBCs and background.
3	9/23/98	Upper - 1 Lower - 1	VOCs, SVOCs, metals	

Notes:
( ) – Parenthesis indicate number of samples proposed
Standard Suite – VOCs, SVOCs, metals, cyanide, pesticides and PCBs at DQO Level III.
a – Additional analysis performed on one sample on 09/18/95 included cation, chloride, sulfur, ammonia, nitrate/nitrite, phosphorus, TOC and total moisture.
b – Duplicates were submitted for Appendix IX parameters at DQO Level IV.

10.4.2 Nature and Extent of Contamination in Soil

Summaries of organic compound analytical results for soil are presented in Table 10.4.2. Inorganic analytical results for soil are presented in Table 10.4.3. Table 10.4.4 summarizes all analytes detected in soil at AOC 678/679. Appendix D is a complete analytical data report for all samples collected in Zone I.

Table 10.4.2
AOC 678/679
Organic Compound Analytical Results for Soil (μg/kg)

Parameters	Sampling Interval	Detection Frequency	Detection Range	Mean	RBC (upper) SSL (lower	Number of Samples Exceeding RBC or SSL
Volatile Organics						
Acetone	Upper	10/20	8.00 - 50.0	26.8	780,000	0
	Lower	7/12	8.0 - 29.0	17.4	8,000	0
Toluene	Upper	11/20	1.0 - 4.0	2.27	1,600,000	0
	Lower	5/12	1.0 - 7.0	4.20	6,000	0

Table 10.4.2
AOC 678/679
Organic Compound Analytical Results for Soil (μg/kg)

Parameters	Sampling Interval	Detection Frequency	Detection Range	Mean	RBC (upper) SSL (lower	Number of Samples Exceeding RBC or SSL
Trichlorotriflouroethane	Upper	1/20	4.00	4.0	230,000,000	0
	Lower	0/12	ND	ND	NA	0
Semivolatile Organics						
Acetophenone	Upper	1/20	240	240	780,000	0
	Lower	0/12	ND	ND	0.12	0
Anthracene	Upper	1/20	46.0	46.0	2,300,000	0
	Lower	0/12	ND	ND	5,900,000	0
1-Methylnapthalene	Upper	1/20	39.0	39.0	310,000	0
	Lower	0/12	ND	ND	72,000	0
2-Methylnapthalene	Upper	1/20	110	110	310,000	0
	Lower	0/12	ND	ND	230,000	0
BEQ	Upper	4/20	37.1 - 253	110	87	1
	Lower	2/12	0.05 - 128	64.0	1,600	0
Benzo(a)anthracene	Upper	3/20	27.0 - 180	87.7	870	0
	Lower	1/12	75.0	75.0	800	0
Benzo(a)pyrene	Upper	4/20	29.0 - 200	85.8	87	1
	Lower	1/12	96.0	96.0	4,000	0
Benzo(b)fluoranthene	Upper	4/20	31.0 - 240	133	870	0
	Lower	1/12	220	220	2,500	0
Benzo(k)fluoranthene	Upper	4/20	21.0 - 170	100	8,700	0
	Lower	1/12	230	230	25,000	0
Chrysene	Upper	3/20	23.0 - 200	94.0	87,000	0
	Lower	2/12	50.0 - 110	80.0	80,000	0
Indeno(1,2,3)pyrene	Upper	2/20	21.0 - 97.0	59.0	870	0
	Lower	0/12	ND	ND	7,000	0
Benzo(g,h,i)perylene	Upper	1/20	110	110	310,000	0
	Lower	0/12	ND	ND	1.2E8	0
Di-n-butylphthalate	Upper	7/20	40.0 - 80.0	59.7	780,000	0
	Lower	5/12	53.0 - 220	101	2,300,000	0
Fluoranthene	Upper	4/20	26.0 - 330	121	310,000	0
	Lower	3/12	50.0 - 120	76.7	2,100,000	0
Naphthalene	Upper	2/20	60.0 - 68.0	64.0	310,000	0
	Lower	2/12	ND	ND	42,000	0
Phenanthrene	Upper	3/20	15.0 - 220	107	230,000	0
	Lower	2/12	40.0 - 67.0	53.5	660,000	0
Pyrene	Upper	4/20	33.0 - 330	128	230,000	0
	Lower	3/12	40.0 - 100	76.7	2,100,000	0
bis(2-Ethylhexyl)phthalate	Upper	2/20	55.0 - 240	148	46,000	0
	Lower	0/12	ND	ND	1,800,000	0

Table 10.4.2
AOC 678/679
Organic Compound Analytical Results for Soil (μg/kg)

Parameters	Sampling Interval	Detection Frequency	Detection Range	Mean	RBC (upper) SSL (lower	Number of Samples Exceeding RBC or SSL
Methapyrilene	Upper	1/20	50.0	50.0	NA	0
	Lower	0/12	ND	ND	NA	0
Ethyl methacrylate	Upper	1/20	40.0	40.0	700,000	0
	Lower	0/12	ND	ND	1,500	0
Isodrin	Upper	2/20	990 - 1,000	995	NA	0
	Lower	0/12	ND	ND	NA	0
Pesticides/PCBs and Herbicides						
4,4'-DDD	Upper	7/20	9.50 - 170	62.1	2,700	0
	Lower	2/12	2.90 - 42.0	22.5	8,000	0
4,4'-DDE	Upper	11/20	4.0 - 480	67.4	1,900	0
	Lower	3/12	3.70 - 28.0	13.1	27,000	0
4,4'-DDT	Upper	5/20	4.30 - 86.0	28.9	1,900	0
	Lower	1/12	4.60	4.60	16,000	0
2,4,5-T	Upper	0/3	ND	ND	78,000	0
	Lower	1/3	3.40	3.40	990	0
Aroclor-1260	Upper	0/20	ND	ND	320	0
	Lower	1/12	27.0	27.0	1,000	0
Endrin	Upper	3/20	6.10 - 12.0	8.10	2,300	0
	Lower	0/12	ND	ND	500	0
Endrin aldehyde	Upper	5/20	1.10 - 1.30	1.20	2,300	0
	Lower	0/12	ND	ND	340	0
Methoxychlor	Upper	1/20	22.0	22.0	39,000	0
	Lower	1/12	4.0	4.0	80,000	0
beta-BHC	Upper	2/20	1.40 - 2.0	1.70	350	0
	Lower	0/12	ND	ND	1.3	0
Organophosphate Pesticides						
Famphur	Upper	0/20	ND	ND	47,000	0
	Lower	1/12	5.70	5.70	27,000	0
Methyl parathion	Upper	1/20	3.90	3.90	2,000	0
	Lower	0/12	ND	ND	150	0
Phorate	Upper	1/3	10.0	10.0	1.6	1
	Lower	0/3	ND	ND	820	0
Organotins						
Tributyltin	Upper	0/20	ND	ND	2300	0
	Lower	1/12	2.70	2.70	NA	0
Dioxins & Furans						
TEQ	Upper	2/2	9.90E-6 - 3.71E-3	1.86E-3	4.3E-3	0
	Lower	1/1	1.04E-4	1.04E-4	1.6	0

Table 10.4.2
AOC 678/679
Organic Compound Analytical Results for Soil (μg/kg)

Parameters	Sampling Interval	Detection Frequency	Detection Range	Mean	RBC (upper) SSL (lower	Number of Samples Exceeding RBC or SSL
1234678-HpCDD	Upper	1/2	0.147	0.147	0.43	0
	Lower	0/1	2.10E-3	2.10E-3	108	0
1234678-HpCDF	Upper	1/2	5.94E-3	5.94E-4	0.43	0
	Lower	0/1	ND	ND	54.0	0
123789-HxCDF	Upper	0/2	ND	ND	0.043	0
	Lower	1/1	4.92E-4	4.92E-4	216	0
123678-HxCDD	Upper	1/2	2.06E-3	2.06E-3	0.043	0
	Lower	0/1	ND	ND	4.1	0
123789-HxCDD	Upper	1/2	7.41E-4	7.41E-4	0.043	0
	Lower	0/1	ND	ND	4.1	0
123478-HxCDF	Upper	1/2	1.94E-3	1.94E-3	0.043	0
	Lower	0/1	ND	ND	216	0
OCDD	Upper	2/2	9.90E-3 - 1.70	0.85	4.3	0
	Lower	1/1	0.033	0.033	1,080	0
OCDF	Upper	1/2	8.17E-3	8.17E-3	4.3	0
	Lower	1/1	4.77E-4	4.77E-4	540	0

Notes:
NA = Not applicable/Not available/Not analyzed
ND = Not detected/Not determined
NL = Not listed
μg/kg = micrograms per kilogram
See Table 5.5 for organic screening concentrations and their sources

Table 10.4.3
AOC 678/679
Inorganic Analytical Results for Soil (mg/kg)

Parameter	Sample Interval	Detection Frequency	Detection Range	Mean	Background	RBC (upper) SSL (lower)	Number of Samples Exceeding RBC or SSL and background
Aluminum (Al)	Upper	23/23	3,090 - 7,580	5,536	27,400	7,800	0
	Lower	13/13	908 - 9,150	3,710	18,900	560,000	0
Antimony (Sb)	Upper	4/23	0.21 - 0.39	0.303	ND	3.1	0
	Lower	0/13	ND	ND	ND	2.7	0
Arsenic (As)	Upper	15/23	0.40 - 7.40	1.21	21.6	0.43	0
	Lower	8/13	0.54 - 7.0	2.44	6.45	820	0
Barium (Ba)	Upper	23/23	5.90 - 98.5	17.4	54.2	550	0
	Lower	13/13	3.6 - 58.6	12.2	36	820	0

Table 10.4.3
AOC 678/679
Inorganic Analytical Results for Soil (mg/kg)

Parameter	Sample Interval	Detection Frequency	Detection Range	Mean	Background	RBC (upper) SSL (lower)	Number of Samples Exceeding RBC or SSL and background
Beryllium (Be)	Upper	12/23	0.03 - 0.41	0.118	0.95	16	0
	Lower	9/13	0.09 - 0.52	0.24	0.67	32	0
Cadmium (Cd)	Upper	5/23	0.12 - 0.50	0.278	0.61	7.8	0
	Lower	3/13	0.09 - 0.44	0.30	0.54	4	0
Chromium (Cr)	Upper	23/23	6.5 - 116	24.9	34.5	39	4
	Lower	13/13	5.1 - 28.3	13.4	51.3	19	0
Cobalt (Co)	Upper	21/23	0.64 - 10.7	1.53	5.8	470	0
	Lower	10/13	0.51 - 4.6	1.53	3.48	990	0
Copper (Cu)	Upper	17/23	0.89 - 15.7	4.34	240	310	0
	Lower	12/13	0.76 - 67.3	7.78	11.5	5,600	0
Lead (Pb)	Upper	23/23	3.90 - 31.0	8.72	203	400	0
	Lower	13/13	1.80 - 468	39.4	12.3	400	1
Manganese (Mn)	Upper	22/23	7.50 - 81.4	34.2	419	160	0
	Lower	12/13	16.5 - 338	55.4	118	480	0
Mercury (Hg)	Upper	4/23	0.12 - 0.29	0.195	0.47	2.3	0
	Lower	1/13	3.10	3.10	ND	1	1
Nickel (Ni)	Upper	23/23	1.90 - 9.30	3.41	23.9	160	0
	Lower	12/13	0.92 - 13.3	4.19	15.7	65	0
Selenium (Se)	Upper	6/23	0.49 - 0.82	0.612	1.49	39	0
	Lower	7/13	0.20 - 0.85	0.626	1.77	2.6	0
Tin (Sn)	Upper	17/23	0.97 - 2.2	1.33	7.5	4,700	0
	Lower	5/13	1.10 - 2.40	1.48	ND	5,500	0
Vanadium (V)	Upper	21/23	5.40 - 32.3	9.55	113	55	0
	Lower	13/13	3.40 - 18.2	8.35	38.1	3,000	0
Zinc (Zn)	Upper	23/23	4.20 - 87.6	17.7	206	2,300	0
	Lower	13/13	7.0 - 189	25.6	36.2	6,200	0

Notes:
NA = Not applicable/Not available/Not analyzed
ND = Not detected/Not determined
NL = Not listed
mg/kg = milligrams per kilogram
See Table 5.6 for inorganic screening concentrations and their sources

Table 10.4.4
AOC 678/679
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Volatiles Organic Carbons (µg/kg)							
Acetone	678SB001	17	780000	NA	17	8000	NA
	678SB002	ND			25		
	678SB003	28			19		
	678SB006	ND			12.5		
	679SB002	15			NT		
	679SB003	50			NT		
	679SB004	16			NT		
	679SB005	ND			11		
	679SB006	8			NT		
	679SB007	31			NT		
	679SB008	38			NT		
	679SB009	49			ND		
	679SB010	ND			29		
	679SB011	16			8		
Toluene	678SB001	ND	1600000	NA	1	6000	NA
	678SB003	4			7		
	678SB005	1			NT		
	678SB006	NT			5		
	678SB007	2			ND		
	678SB008	4			ND		
	678SB011	2			NT		
	678SB012	ND			2		
	679SB002	1			NT		
	679SB004	1			NT		
	679SB008	2			NT		
	679SB009	2			ND		
	679SB011	3			ND		
	679SB012	3			6		
Trichlorotriflouroethane	678SB001	4	230000000	NA	NT	NA	NA

Table 10.4.4
AOC 678/679
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Semivolatiles Organic Carbons ($\mu g/kg$)							
BEQs	678SB001	56	87	NA	NA	1600	NA
	678SB003	**253**			NA		
	678SB008	**92**			NA		
	678SB012	ND			128		
	679SB005	ND			0.05		
	679SB015	37			NA		
Benzo(a)anthracene	678SB003	180	870	NA	ND	800	NA
	678SB008	56			ND		
	678SB012	ND			75		
	679SB015	27			ND		
Benzo(a)pyrene	678SB001	45	87	NA	ND	4000	NA
	678SB003	**200**			ND		
	678SB008	69			ND		
	678SB012	ND			96		
	679SB015	29			ND		
Benzo(b)fluoranthene	678SB001	100	870	NA	ND	2500	NA
	678SB003	240			ND		
	678SB008	160			ND		
	678SB012	ND			220		
	679SB015	31			ND		
Benzo(k)fluoranthene	678SB001	110	8700	NA	ND	25000	NA
	678SB003	100			ND		
	678SB008	170			ND		
	678SB012	ND			230		
	679SB015	21			ND		

Table 10.4.4
AOC 678/679
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Chrysene	678SB003	200	87000	NA	ND	80000	NA
	678SB008	59			ND		
	678SB012	ND			110		
	679SB005	ND			50		
	679SB015	23			ND		
Indeno(1,2,3-cd)pyrene	678SB003	97	870	NA	ND	7000	NA
	679SB015	21			ND		
1-Methylnaphthalene	678SB001	39	310000	NA	ND	72000	NA
2-Methylnapthalene	678SB001	110	310000	NA	ND	230000	NA
Acetophenone	679SB008	240	780000	NA	NT	0.12	NA
Anthracene	678SB003	46	2300000	NA	ND	5900000	NA
Bis(2-ethylhexyl)phthalate (BEHP)	678SB006	240	46000	NA	ND	1800000	NA
	679SB015	55			ND		
Di-n-butylphthalate	678SB002	78	780000	NA	53	2300000	NA
	679SB005	80			70		
	679SB006	50			NT		
	679SB007	40			NT		
	679SB008	50			NT		
	679SB009	ND			70		
	679SB010	60			90		
	679SB011	60			220		
Ethyl methacrylate	679SB011	40	700000	NA	ND	1500	NA

Table 10.4.4
AOC 678/679
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Fluoranthene	678SB001	50	310000	NA	ND	2100000	
	678SB003	330			ND		
	678SB008	76			ND		
	678SB012	ND			120		
	679SB005	ND			60		
	679SB010	ND			50		
	679SB015	26			ND		
Isodrin	679SB006	990	NA	NA	ND	NA	NA
	679SB007	1000			ND		
Methapyrilene	679SB007	50	NA	NA	ND	NA	NA
Naphthalene	678SB001	68	310000	NA	ND	42000	NA
	679SB008	60			NT		
Phenanthrene	678SB001	86	230000		ND	660000	NA
	678SB003	220			ND		
	678SB012	ND			67		
	678SB010	ND			40		
	679SB015	15			ND		
Pyrene	678SB001	80	230000	NA	ND	2100000	NA
	678SB003	330			ND		
	678SB008	68			ND		
	678SB012	ND			100		
	679SB005	ND			90		
	679SB010	ND			40		
	679SB015	33			ND		
Pesticides/PCBs (μg/kg)							
Aroclor-1260	679SB010	ND	320		27	1000	NA

Table 10.4.4
AOC 678/679
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
4.4'-DDD	678SB001	22	2700	NA	ND	8000	NA
	678SB003	25			ND		
	678SB007	170			2.9		
	678SB008	120			ND		
	678SB012	77			42		
	679SB002	11.5			NT		
	679SB008	9.5			NT		
4,4'-DDE	678SB001	16	1900	NA	ND	27000	NA
	678SB003	54			3.7		
	678SB005	4			NT		
	678SB006	5.3			ND		
	678SB007	480			7.7		
	678SB008	110			ND		
	678SB012	31			28		
	679SB002	8.3			8.3		
	679SB005	13			13		
	679SB006	13			13		
	679SB009	7			7		
4,4'-DDT	678SB001	4.3	1900	NA	ND	16000	NA
	678SB006	7			ND		
	678SB007	42			ND		
	678SB008	86			ND		
	678SB012	ND			4.6		
	679SB015	5.1			ND		
beta-BHC	679SB006	2	350	NA	NT	1.3	NA
	679SB007	1.4			NT		
Endrin	678SB003	6.2	2300	NA	ND	500	NA
	678SB008	12			ND		
	678SB012	6.1					

Table 10.4.4
AOC 678/679
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Endrin aldehyde	678SB001	1.3	2300	NA	ND	340	NA
	678SB003	1.2			ND		
	678SB012	1.2			ND		
	679SB005	1.2			ND		
	679SB006	1.1			NT		
Methoxychlor	678SB012	ND	39000	NA	4	80000	NA
	679SB006	22			NT		
Organophosphate Pesticides (µg/kg)							
Famphur	678SB006	ND	47000	NA	5.7	27000	NA
Methyl parathion	679SB002	3.9	2000	NA	NT	150	
Phorate	679SB011	10	1.6	NA	ND	820	
Herbicides (µg/kg)							
2,4,5-T	678SB006	ND	78000	NA	3.4	990	NA
Dioxins (ng/kg)							
Dioxin (2,3,7,8-TCDD TEQs)	678SB006	NT	4.3	NA	0.136	1600	NA
	679SB002	0.01			NT		
	679SB011	3.72			NT		
Organotins (µg/kg)							
Tributyltin	678SB007	ND	2300	NA	2.7	NA	NA

Table 10.4.4
AOC 678/679
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Inorganics (mg/kg)							
Aluminum (Al)	678SB001	6870	7800	27400	2180	560000	18900
	678SB002	5040			3070		
	678SB003	3090			2190		
	678SB005	5040			NT		
	678SB006	4640			978		
	678SB007	3660			3280		
	678SB008	4460			908		
	678SB011	4520			NT		
	678SB012	5740			8290		
	678SB013	7460			NT		
	678SB014	6170			NT		
	679SB002	5695			NT		
	679SB003	5690			NT		
	679SB004	5030			NT		
	679SB005	5010			9150		
	679SB006	6850			NT		
	679SB007	7220			NT		
	679SB008	5690			NT		
	679SB009	6400			2730		
	679SB010	6820			1890		
	679SB011	3435			4800		
	679SB012	5230			5200		
	679SB015	7580			3570		
Antimony (Sb)	678SB013	0.35	3.1	ND	NT	2.7	ND
	678SB014	0.39			NT		
	679SB003	0.26			NT		
	679SB005	0.21			ND		

Table 10.4.4
AOC 678/679
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Arsenic (As)	678SB001	7.4	0.43	21.6	ND	15	6.45
	678SB002	ND			4.1		
	678SB008	ND			1		
	678SB011	1.3			NT		
	678SB012	0.7			7		
	678SB013	0.66			NT		
	678SB014	0.75			NT		
	679SB002	0.57			NT		
	679SB004	0.51			NT		
	679SB005	0.74			3.0		
	679SB006	0.45			NT		
	679SB007	0.45			NT		
	679SB008	0.6			NT		
	679SB009	0.4			0.73		
	679SB010	ND			0.54		
	679SB011	1.2			ND		
	679SB012	0.73			0.56		
	679SB015	1.7			2.6		

Table 10.4.4
AOC 678/679
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Barium (Ba)	678SB001	40.9	550	54.2	7.2	820	36
	678SB002	7.1			14.7		
	678SB003	11.5			4.8		
	678SB005	10.5			NT		
	678SB006	10.9			4.4		
	678SB007	18.3			7		
	678SB008	14.8			3.6		
	678SB011	7.7			NT		
	678SB012	11			58.6		
	678SB013	11.5			NT		
	678SB014	11.6			NT		
	679SB002	17			NT		
	679SB003	9.7			NT		
	679SB004	5.9			NT		
	679SB005	8.1			13.9		
	679SB006	11.3			NT		
	679SB007	11.2			NT		
	679SB008	26.4			NT		
	679SB009	10.1			6.4		
	679SB010	10.7			6.1		
	679SB011	9.5			12.5		
	679SB012	6.9			7.9		
	679SB015	30.2			11		

Table 10.4.4
AOC 678/679
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Beryllium (Be)	678SB001	0.41	16	0.95	ND	32	0.67
	678SB002	ND			0.28		
	678SB007	ND			0.22		
	678SB012	ND			0.52		
	679SB003	0.03			NT		
	679SB004	0.07			NT		
	679SB005	0.11			0.24		
	679SB006	0.06			NT		
	679SB007	0.04			NT		
	679SB008	0.17			NT		
	679SB009	0.08			0.15		
	679SB010	0.04			0.11		
	679SB011	0.14			0.14		
	679SB012	0.08			0.09		
	679SB015	0.18			0.42		
Cadmium (Cd)	678SB001	0.50	7.8	0.61	ND	4	0.54
	678SB007	0.12			0.09		
	678SB008	0.17			ND		
	678SB011	0.16			NT		
	678SB012	ND			0.44		
	679SB015	0.44			0.36		

Table 10.4.4
AOC 678/679
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Chromium (Cr)	678SB001	27.7	39	34.5	10	19	51.3
	678SB002	6.5			13.8		
	678SB003	28			16.5		
	678SB005	29.5			NT		
	678SB006	**116**			5.4		
	678SB007	11.9			14.4		
	678SB008	35.8			5.1		
	678SB011	10.7			NT		
	678SB012	36.6			25.3		
	678SB013	**41.7**			NT		
	678SB014	34.5			NT		
	679SB002	**44.8**			NT		
	679SB003	7.7			NT		
	679SB004	8.5			NT		
	679SB005	12.1			28.3		
	679SB006	13.9			NT		
	679SB007	15.2			NT		
	679SB008	21.8			NT		
	679SB009	8.7			8.7		
	679SB010	10.5			7.3		
	679SB011	32.1			10		
	679SB012	16.6			16.5		
	679SB015	18.1			13.3		

Table 10.4.4
AOC 678/679
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Cobalt (Co)	678SB001	3.9	470	5.8	ND	990	3.48
	678SB002	ND			1.2		
	678SB003	10.7			1.6		
	678SB006	1			ND		
	678SB007	0.75			1		
	678SB008	1.1			ND		
	678SB011	1.2			NT		
	678SB012	1.1			4.6		
	678SB013	0.81			NT		
	678SB014	1.5			NT		
	679SB002	0.95			NT		
	679SB003	0.64			NT		
	679SB004	0.78			NT		
	679SB005	0.83			1.7		
	679SB006	0.9			NT		
	679SB007	0.88			NT		
	679SB008	0.65			NT		
	679SB009	0.8			0.68		
	679SB010	0.76			0.51		
	679SB011	1			1.4		
	679SB012	1			0.86		
	679SB015	0.92			1.7		

Table 10.4.4
AOC 678/679
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Copper (Cu)	678SB001	15.1	310	240	3.9	5600	11.5
	678SB002	ND			3		
	678SB003	5.6			3.3		
	678SB006	1.9			1.1		
	678SB007	15.7			4.8		
	678SB008	7.1			0.76		
	678SB011	2.5			NT		
	678SB012	1.8			67.3		
	678SB013	0.89			NT		
	678SB014	2.8			NT		
	679SB002	2.2			NT		
	679SB005	1.7			3.1		
	679SB006	2.8			NT		
	679SB008	1.7			NT		
	679SB009	1.2			1.4		
	679SB011	2.5			1.2		
	679SB012	1.2			2.1		
	679SB015	7.6			1.4		

Table 10.4.4
AOC 678/679
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Lead(Pb)	678SB001	13.1	400	203	2.9	400	12.3
	678SB002	3.9			6.8		
	678SB003	10.5			2.2		
	678SB005	4.3			NT		
	678SB006	4.5			1.8		
	678SB007	31			3		
	678SB008	25.5			1.8		
	678SB011	8.7			NT		
	678SB012	7.4			**468**		
	678SB013	5.5			NT		
	678SB014	5.5			NT		
	679SB002	3.5			NT		
	679SB003	5.2			NT		
	679SB004	4			NT		
	679SB005	4.7			6.6		
	679SB006	8.3			NT		
	679SB007	5.5			NT		
	679SB008	6.2			NT		
	679SB009	5.6			4.4		
	679SB010	5			3.1		
	679SB011	4.1			3.7		
	679SB012	3.9			5.3		
	679SB015	24.2			2.1		

Table 10.4.4
AOC 678/679
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Manganese (Mn)	678SB001	35.8	160	419	27.4	480	118
	678SB002	7.5			31.7		
	678SB003	34.9			19.9		
	678SB005	18.3			NT		
	678SB006	62.7			13.1		
	678SB007	30.8			38.4		
	678SB008	27.6			ND		
	678SB011	64			NT		
	678SB012	ND			338		
	678SB013	23.2			NT		
	678SB014	43.4			NT		
	679SB002	60.3			NT		
	679SB003	10.4			NT		
	679SB004	28.1			NT		
	679SB005	23.9			58.4		
	679SB006	13.8			NT		
	679SB007	14.7			NT		
	679SB008	61.6			NT		
	679SB009	15.8			24.4		
	679SB010	25.7			17.6		
	679SB011	35.3			16.5		
	679SB012	39.3			29.2		
	679SB015	81.4			46.8		
Mercury (Hg)	678SB001	0.29	2.3	0.47	ND	1	ND
	678SB007	0.24			ND		
	678SB008	0.12			ND		
	678SB012	ND			**3.1**		
	679SB015	0.13			ND		

Table 10.4.4
AOC 678/679
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Nickel (Ni)	678SB001	7.1	160	23.9	ND	65	15.7
	678SB002	2			5.6		
	678SB003	4.1			5.5		
	678SB005	1.9			NT		
	678SB006	3.2			1.15		
	678SB007	2.6			5.2		
	678SB008	3.9			0.92		
	678SB011	4.1			NT		
	678SB012	2.4			13.3		
	678SB013	3.1			NT		
	678SB014	3			NT		
	679SB002	3			NT		
	679SB003	2.1			NT		
	679SB004	3.3			NT		
	679SB005	3			6.1		
	679SB006	3.5			NT		
	679SB007	2.8			NT		
	679SB008	2.5			NT		
	679SB009	2.8			2.2		
	679SB010	3			1.2		
	679SB011	3.1			1.8		
	679SB012	2.9			4		
	679SB015	9.3			3.3		

Table 10.4.4
AOC 678/679
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Selenium (Se)	678SB001	0.78	39	1.49	ND	2.6	1.77
	678SB002	ND			0.85		
	678SB003	ND			0.69		
	678SB007	0.5			0.6		
	678SB008	0.51			ND		
	678SB012	ND			0.67		
	679SB004	0.49			NT		
	679SB005	ND			0.79		
	679SB009	0.82			0.58		
	679SB011	0.57			ND		
	679SB015	ND			0.2		
Tin (Sn)	678SB002	1.3	4700	7.5	ND	5500	ND
	678SB003	1.2			ND		
	678SB005	1.4			NT		
	678SB006	1.5			1.3		
	678SB007	2.2			ND		
	678SB008	1.5			1.5		
	678SB011	1			NT		
	678SB012	1.2			2.4		
	678SB013	1.8			NT		
	678SB014	1.4			NT		
	679SB002	1.2			NT		
	679SB003	1.7			NT		
	679SB004	0.99			NT		
	679SB006	1.1			NT		
	679SB009	1.1			ND		
	679SB011	1			1.1		
	679SB012	0.97			1.1		

Table 10.4.4
AOC 678/679
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Vanadium (V)	678SB001	12.2	55	113	5.3	3000	38.1
	678SB002	7.6			10.5		
	678SB003	6.8			8.2		
	678SB005	7.8			NT		
	678SB006	5.9			3		
	678SB007	6.4			10.5		
	678SB008	8.2			3.6		
	678SB011	6.9			NT		
	678SB012	9.2			18.2		
	679SB002	7.5			NT		
	679SB003	9.7			NT		
	679SB004	5.4			NT		
	679SB005	6.9			15.6		
	679SB006	10.5			NT		
	679SB007	11.8			NT		
	679SB008	9.2			NT		
	679SB009	9.6			6		
	679SB010	10.8			4.5		
	679SB011	8.8			6.7		
	679SB012	5.7			6.6		
	679SB015	32.3			9.4		

Table 10.4.4
AOC 678/679
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Zinc (Zn)	678SB001	30.9	23000	206	11.5	6200	36.2
	678SB002	4.9			16.5		
	678SB003	35.1			20.6		
	678SB005	4.7			NT		
	678SB006	5			6.1		
	678SB007	61.8			18.2		
	678SB008	87.6			7.4		
	678SB011	15.8			NT		
	678SB012	7.7			189		
	678SB013	4.2			NT		
	678SB014	4.3			NT		
	679SB002	9.5			NT		
	679SB003	6.5			NT		
	679SB004	7.5			NT		
	679SB005	10.5			16.3		
	679SB006	9.9			NT		
	679SB007	8.5			NT		
	679SB008	6.3			NT		
	679SB009	7.7			9.5		
	679SB010	5.3			7		
	679SB011	13.5			8.8		
	679SB012	7.8			9.6		
	679SB015	46			11.6		

Notes:
* = Residential RBCs (THQ=0.1) were used as a reference concentration for upper interval samples. Generic soil to groundwater SSLs (DAF=20) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996) were used as a reference concentration for lower interval samples.
ND = Not detected.
NT = Not taken.
NL = Not listed.
NA = Not applicable.
Bolded concentrations exceed both the reference concentration (RBC or SSL) and the zone background.
All background reference values for Zone I are based on twice the means of the grid sample concentrations.

Volatile Organic Compounds in Soil

Three VOCs were detected in surface soil at AOC 678/679, but at concentrations far below their RBCs: acetone, trichlorotriflouroethane (Freon 113), and toluene. Acetone and toluene were also detected in subsurface soil also at concentrations far below their respective SSLs.

The VOCs acetone and toluene were detected in the surface and subsurface soil at grid soil boring GDISB014. Acetone was detected in the surface soil sample GDISB01401 at 22μg/kg and toluene was detected in this sample at 3μg/kg. Acetone was detected in the subsurface soil sample GDISB01402 at 110μg/kg and toluene was detected at 2μg/kg. These detections were far below their respective RBCs and SSLs.

Semivolatile Organic Compounds in Soil

Twenty SVOCs were detected in surface soils at AOC 678/679. Benzo(a)pyrene was detected at 200μg/kg (RBC=87μg/kg). Nine SVOCs were detected in the subsurface, but at concentrations far below their SSLs: benzo(a)anthracene, benzo(a)pyrene, benzo(b)flouranthene, benzo(k)fluoranthene, chrysene, di-n-butylphthalate, fluoranthene, phenanthrene, and pyrene. All other surface and subsurface soil SVOC detections were far below their respective RBCs and SSLs.

One SVOC, di-n-butylphthalate, was detected in surface and subsurface soil at grid soil boring GDISB014. The results, GDISB01401 (100μg/kg) and GDISB01402 (130μg/kg), were below RBC and SSL concentrations.

In accordance with recent cPAH guidance, (USEPA *Interim Supplemental Guidance to **RAGS**: Region IV Bullentins, Human Health Risk Assessment, Bullentin No. 2* [USEPA 1995c]), BEQs were calculated for cPAHs at AOC 678/679. The results, for calculated BEQs, were 678SB00101=56.1μg/kg, 678SB00301=252.9μg/kg, 678SB00801=92.4μg/kg, 678SB01202 = 128μg/kg, 679SB00502 = 0.05μg/kg, and 679SB01501 = 37.1μg/kg. The BEQ for surface soil samples 678SB00301 and 678SB00801 exceeded the RBC of 87.00 μg/kg.

Pesticides and PCBs in Soil

Nine pesticides were detected in surface soil at AOC 678/679. One pesticide, phorate, exceeded its RBC of 1.6 μg/kg in sample 679SB01101. Phorate was detected at 10 μg/kg. Seven pesticides were detected in the subsurface soil. All other surface and subsurface samples were far below their RBCs and SSLs.

Three pesticides were detected in surface soil at grid soil boring GDISB01401, at concentrations far below their respective RBCs. No pesticides were detected in the subsurface soil at GDISB01402.

Other Organic Compounds in Soil

Tributyltin was detected in subsurface soil at 2.70 μg/kg, below the tributyltin oxide RBC of 2300 μg/kg.

Dioxins were detected in soil at AOC 678/679. In accordance with the recent dioxin guidance and Section 7 of this report, TEQs were calculated. The maximum TEQ for the surface sample was calculated at 3.71E-3 μg/kg and the calculated TEQ for the subsurface sample was 1.04E-4 μg/kg, well below the RBC and SSL.

Inorganics in Soil

Seventeen metals were detected in surface soil at AOC 678/679. Only chromium exceeded its RBC and background. Chromium exceeded its RBC (39 mg/kg) and surface background concentration (34.5 mg/kg) in four surface samples. Sixteen metals were detected in the subsurface soil. Lead and mercury exceeded their SSL and subsurface background concentration each in one sample. No other subsurface samples exceeded their SSL and background.

Twelve metals were detected in surface soil at grid soil boring GDISB014. Two metals, barium and chromium, exceed their RBC and surface background values in the surface soil sample. Barium was detected in the surface soil sample at 1180 mg/kg, and chromium at 268 mg/kg. The remaining surface samples did not exceed their respective RBC and background.

Nine metals were detected in the subsurface sample from GDISB014. None of these detections exceeded the SSL and background values.

10.4.3 Groundwater Sampling and Analysis

The *Final Zone I RFI Work Plan* (E/A&H, February 1995) proposed three shallow monitoring wells at AOC 678/679. Subsequent to the work plan, geoprobe samples were collected to further define the extent of contamination at former firefighter "mock up" areas, and a fourth well was installed at the wash rack site. Six rounds of groundwater sampling were completed. During the first round of sampling, wells were sampled for VOCs, SVOCs, metals, cyanide, pesticides, PCBs, organotins, chlorides, TDS, and sulfates at DQO Level III. Samples from rounds two and three were analyzed for cyanide and metals. Fourth round samples were analyzed for chloride, cyanide, sulfate, metals, pesticides, VOCs, and TDS. Fifth round samples were taken from five shallow and four deep geoprobe samples collected along the boundary between AOC 679 and 680. These samples were analyzed for VOCs and SVOCs. A duplicate sample was taken in rounds two, three, four, and five. Sixth round sampling was conducted on well 679001 only and samples were analyzed for VOCs only. In addition, a shallow and deep grid-based monitoring well pair, GDI014 and GDI14D, was proposed and installed for use in characterizing the zone perimeter groundwater. Table 10.4.5 summarizes the groundwater sampling at AOC 678/679.

Groundwater samples were also collected from a shallow/deep grid monitoring well pair (GDI014/GDI14D). Both wells were sampled during the first four sampling events, and all samples were analyzed for the standard suite of parameters, plus chloride, sulfate, and TDS. Results of these analyses are discussed in the AOC 678 and 679 nature and extent section and are presented in Appendix D.

Table 10.4.5
AOC 678/679
Groundwater Sampling Summary

Sampling Round	Sampling Date	Number of Wells	Sample Analyses	Comments
1	05/22/95 06/06/95 06/08/95	3	Standard Suite, Organotins, Chlorides, TDS, Sulfates	
2	01/15/96	3	Cyanide, Metals	
		Duplicate - 1	Cyanide, Metals	
3	05/24/96 06/04/96	3	Cyanide, Metals	
	06/05/96	Duplicate - 1	Cyanide, Metals	
4	09/09/96 09/11/96	3	Chloride, Cyanide, Sulfate, Metals, Pesticides, VOCs, TDS	
		Duplicate -1	Appendix IX	
5	03/16/98 03/17/98	5	VOCs, SVOCs	Five shallow and four deep geoprobe samples were collected along the boundary between AOC 679 and AOC 680.
	03/19/98	Duplicate - 1	VOCs, SVOCs	
6	10/19/98	1	VOCs	Only Well 679001 was sampled during this round.

Notes:
Standard Suite – VOCs, SVOCs, metals, cyanide, pesticides and PCBs at DQO Level III.
Appendix IX – Analyses included pesticides and VOCs only, plus chloride, cyanide, sulfate, metals and TDS.

Figure 10.4.1 shows the AOC 678/679 monitoring well locations. All shallow monitoring wells were installed between 12.5 to 13.0 feet bgs in the upper sand layer of the Wando Formation.

Deep well GDI14D was installed at 37.5 feet bgs. All wells were installed in accordance Section 3.2.3 of this report.

10.4.4 Nature and Extent of Contamination for Groundwater

Table 10.4.6 summarizes organic analytical results for groundwater. Table 10.4.7 summarizes inorganic analytical results for groundwater. Table 10.4.8 summarizes all analytes detected in shallow groundwater at AOC 678/679.

Table 10.4.6
AOC 678/679
Organic Compound Analytical Results for Groundwater (μg/L)

Parameters	Sampling Round	Detection Frequency	Detection Range	Mean	Tap Water RBC/MCL	Number of Samples Exceeding RBC/MCL
Volatile Organic Compounds						
Acetone	First	0/3	ND	ND	370/NA	0
	Second	0/0	ND	ND		0
	Third	0/0	ND	ND		0
	Fourth	0/3	ND	ND		0
	Fifth	5/5	6.0 - 28.0	14.6		0
	Sixth	0/1	ND	ND		0
Carbon Disulfide	First	0/3	ND	ND	100/NA	0
	Second	0/0	ND	ND		0
	Third	0/0	ND	ND		0
	Fourth	0/3	ND	ND		0
	Fifth	3/5	0.23 - 0.56	0.35		0
	Sixth	0/1	ND	ND		0
Chlorobenzene	First	0/3	ND	ND	3.5/NA	0
	Second	0/0	ND	ND		0
	Third	0/0	ND	ND		0
	Fourth	0/3	ND	ND		0
	Fifth	1/5	6.5	6.5		1
	Sixth	0/1	ND	ND		0
Methylene chloride	First	1/3	1.0	1.0	4.1/NA	0
	Second	0/0	ND	ND		0
	Third	0/0	ND	ND		0
	Fourth	0/3	ND	ND		0
	Fifth\	0/5	ND	ND		0
	Sixth	0/1	ND	ND		0

Table 10.4.6
AOC 678/679
Organic Compound Analytical Results for Groundwater (μg/L)

Parameters	Sampling Round	Detection Frequency	Detection Range	Mean	Tap Water RBC/MCL	Number of Samples Exceeding RBC/MCL
1,2-Dichloroethene (total)	First	0/3	ND	ND	5.5/NA	0
	Second	0/0	ND	ND		0
	Third	0/0	ND	ND		0
	Fourth	0/3	ND	ND		0
	Fifth	1/5	0.84	0.84		0
	Sixth	0/1	ND	ND		0
Semivolatile Organic Compounds						
Acenaphthene	First	0/3	ND	ND	220/NA	0
	Second	0/0	ND	ND		0
	Third	0/0	ND	ND		0
	Fourth	0/0	ND	ND		0
	Fifth	2/5	1.2 - 2.9	2.65		0
	Sixth	0/1	ND	ND		0
Anthracene	First	0/3	ND	ND	1,100/NA	0
	Second	0/0	ND	ND		0
	Third	0/0	ND	ND		0
	Fourth	0/0	ND	ND		0
	Fifth	1/5	1.0	1.0		0
	Sixth	0/1	ND	ND		0
BEQs	First	0/3	ND	ND	0.0092/0.2	0
	Second	0/0	ND	ND		0
	Third	0/0	ND	ND		0
	Fourth	0/0	ND	ND		0
	Fifth	1/5	0.063	0.063		1
	Sixth	0/1	ND	ND		0
Benzo(a)anthracene	First	0/3	ND	ND	0.092/NA	0
	Second	0/0	ND	ND		0
	Third	0/0	ND	ND		0
	Fourth	0/0	ND	ND		0
	Fifth	1/5	0.62	0.62		1
	Sixth	0/1	ND	ND		0
Chrysene	First	0/3	ND	ND	9.2/NA	0
	Second	0/0	ND	ND		0
	Third	0/0	ND	ND		0
	Fourth	0/0	ND	ND		0
	Fifth	1/5	0.81	0.81		0
	Sixth	0/1	ND	ND		0

Table 10.4.6
AOC 678/679
Organic Compound Analytical Results for Groundwater (μg/L)

Parameters	Sampling Round	Detection Frequency	Detection Range	Mean	Tap Water RBC/MCL	Number of Samples Exceeding RBC/MCL
Bis(2-ethylhexyl)phthalate (BEHP)	First	0/3	ND	ND	4.8/NA	0
	Second	0/0	ND	ND		0
	Third	0/0	ND	ND		0
	Fourth	0/0	ND	ND		0
	Fifth	1/5	1.0	1.0		0
	Sixth	0/1	ND	ND		0
Fluoranthene	First	0/3	ND	ND	150/NA	0
	Second	0/0	ND	ND		0
	Third	0/0	ND	ND		0
	Fourth	0/0	ND	ND		0
	Fifth	2/5	2.8 - 3.0	2.9		0
	Sixth	0/1	ND	ND		0
Phenanthrene	First	0/3	ND	ND	110/NA	0
	Second	0/0	ND	ND		0
	Third	0/0	ND	ND		0
	Fourth	0/0	ND	ND		0
	Fifth	1/5	6.0	6.0		0
	Sixth	0/1	ND	ND		0
Pyrene	First	0/3	ND	ND	110/NA	0
	Second	0/0	ND	ND		0
	Third	0/0	ND	ND		0
	Fourth	0/0	ND	ND		0
	Fifth	2/5	2.6 - 2.8	2.7		0
	Sixth	0/1	ND	ND		0
Fluorene	First	0/3	ND	ND	150/NA	0
	Second	0/0	ND	ND		0
	Third	0/0	ND	ND		0
	Fourth	0/0	ND	ND		0
	Fifth	1/5	2.0	2.0		0
	Sixth	0/1	ND	ND		0
Naphthalene	First	0/3	ND	ND	150/NA	0
	Second	0/0	ND	ND		0
	Third	0/0	ND	ND		0
	Fourth	0/0	ND	ND		0
	Fifth	1/5	4.8	4.8		0
	Sixth	0/1	ND	ND		0

Notes:
NA = Not applicable/Not available
ND = Not detected/Not determined
NL = Not listed
μg/L = micrograms per liter
See Table 5.5 for organic screening concentrations and their sources.

Table 10.4.7
AOC 678/679
Inorganic Analytical Results for Groundwater (μg/L)

Parameters	Sample Round	Detection Frequency	Detection Range	Mean	Tap Water RBC/MCL	Shallow Background	Number of Samples Exceeding Lower of RBC or MCL and Background
Aluminum (Al)	First	1/3	171	171	3,700/NL	1,440	0
	Second	2/3	31.7 - 204	118			0
	Third	0/3	ND	ND			0
	Fourth	2/3	26.2 - 69.1	47.7			0
	Fifth	0/0	ND	ND			0
	Sixth	0/1	ND	ND			0
Arsenic (As)	First	1/3	5.3	5.3	0.045/50	23	0
	Second	0/3	ND	ND			0
	Third	1/3	11.6	11.6			0
	Fourth	0/3	ND	ND			0
	Fifth	0/0	ND	ND			0
	Sixth	0/1	ND	ND			0
Barium (Ba)	First	1/3	11.3	11.3	260/2,000	2.3	0
	Second	2/3	10.1 - 17.6	13.9			0
	Third	0/3	ND	ND			0
	Fourth	2/3	14.9 - 21.8	18.4			0
	Fifth	0/0	ND	ND			0
	Sixth	0/1	ND	ND			0
Cadmium (Cd)	First	1/3	0.30	0.30	1.8/5	NA	0
	Second	0/3	ND	ND			0
	Third	0/3	ND	ND			0
	Fourth	0/3	ND	ND			0
	Fifth	0/0	ND	ND			0
	Sixth	0/1	ND	ND			0
Chromium (Cr)	First	2/3	1.6 - 1.7	1.65	18/100	14.3	0
	Second	2/3	1.3 - 2.65	1.98			0
	Third	0/3	ND	ND			0
	Fourth	0/3	ND	ND			0
	Fifth	0/0	ND	ND			0
	Sixth	0/1	ND	ND			0
Lead (Pb)	First	2/3	2.6 - 3.5	3.05	15/15	4.4	0
	Second	0/3	ND	ND			0
	Third	0/3	ND	ND			0
	Fourth	0/3	ND	ND			0
	Fifth	0/0	ND	ND			0
	Sixth	0/1	ND	ND			0
Manganese (Mn)	First	3/3	42.3 - 245	139	73/NL	5,430	0
	Second	2/3	220 - 338	279			0
	Third	1/3	663	663			0
	Fourth	2/3	126 - 187	157			0
	Fifth	0/0	ND	ND			0
	Sixth	1/1	42.3	42.3			0

Table 10.4.7
AOC 678/679
Inorganic Analytical Results for Groundwater (μg/L)

Parameters	Sample Round	Detection Frequency	Detection Range	Mean	Tap Water RBC/MCL	Shallow Background	Number of Samples Exceeding Lower of RBC or MCL and Background
Nickel (Ni)	First	2/3	1.5 - 2.5	2.0	73/100	13.3	0
	Second	0/3	ND	ND			0
	Third	1/3	1.9	1.9			0
	Fourth	0/3	ND	ND			0
	Fifth	0/0	ND	ND			0
	Sixth	0/1	ND	ND			0
Selenium (Se)	First	0/3	ND	ND	18/50	ND	0
	Second	0/3	ND	ND			0
	Third	0/3	ND	ND			0
	Fourth	1/3	3.1	301			0
	Fifth	0/0	ND	ND			0
	Sixth	0/1	ND	ND			0
Vanadium	First	1/3	1.0	1.0	26/NL	14	0
	Second	0/3	ND	ND			0
	Third	0/3	ND	ND			0
	Fourth	0/3	ND	ND			0
	Fifth	0/0	ND	ND			0
	Sixth	0/1	ND	ND			0
Zinc (Zn)	First	1/3	11.5	11.5	1,100/NL	14	0
	Second	0/3	ND	ND			0
	Third	0/3	ND	ND			0
	Fourth	0/3	ND	ND			0
	Fifth	0/0	ND	ND			0
	Sixth	0/1	ND	ND			0

Notes:
NA = Not applicable/Not available
ND = Not detected/Not determined
NL = Not listed
μg/L = micrograms per liter
See Table 5.6 for inorganic screening concentrations and their sources.

Table 10.4.8
AOC 678/679
Analytes Detected in Shallow Groundwater (μg/L)

Parameters	Location	1st Round Conc.	2nd Round Conc.	3rd Round Conc.	4th Round Conc.	5th Round Conc.	6th Round Conc.	Tap Water RBC*	MCL/ SMCL	Shallow Background
Volatile Organic Compounds										
Acetone	678GP001	NT	NT	NT	NT	7.8	NT	370	NA	NA
	678GP002	NT	NT	NT	NT	28	NT			
	678GP003	NT	NT	NT	NT	13	NT			
	678GP004	NT	NT	NT	NT	18	NT			
	678GP005	NT	NT	NT	NT	6	NT			
Carbon disulfide	678GP001	NT	NT	NT	NT	0.56	NT	100	NA	NA
	678GP004	NT	NT	NT	NT	0.23	NT			
	678GP005	NT	NT	NT	NT	0.26	NT			
Chlorobenzene	678GP002	NT	NT	NT	NT	**6.5**	NT	3.5	NA	NA
1,2-Dichloroethene (total)	678GP003	NT	NT	NT	NT	0.84	NT	5.5	NA	NA
Methylene chloride	678GW002	1	NT	NT	NT	NT	NT	4.1	NA	NA
Semivolatile Organic Compounds										
Acenaphthene	678GP001	NT	NT	NT	NT	1.2	NT	220	NA	NA
	678GP002	NT	NT	NT	NT	2.9	NT			
Anthracene	678GP002	NT	NT	NT	NT	1	NT	1100	NA	NA
Benzo(a)pyrene Equivalents (BEQs)	678GP002	NT	NT	NT	NT	**0.06**	NT	0.0092	0.2	NA
Benzo(a)anthracene	678GP002	NT	NT	NT	NT	**0.62**	NT	0.092	NA	NA
Chrysene	678GP002	NT	NT	NT	NT	0.81	NT	9.2	NA	NA

Table 10.4.8
AOC 678/679
Analytes Detected in Shallow Groundwater (μg/L)

Parameters	Location	1st Round Conc.	2nd Round Conc.	3rd Round Conc.	4th Round Conc.	5th Round Conc.	6th Round Conc.	Tap Water RBC*	MCL/ SMCL	Shallow Background
bis(2-Ethylhexyl)phthalate (BEHP)	678GP001	NT	NT	NT	NT	1	NT	4.8	NA	NA
Fluoranthene	678GP001	NT	NT	NT	NT	2.8	NT	150	NA	NA
	678GP002	NT	NT	NT	NT	3	NT			
Fluorene	678GP002	NT	NT	NT	NT	2	NT	150	NA	NA
Naphthalene	678GP002	NT	NT	NT	NT	4.8	NT	150	NA	NA
Phenanthrene	678GP002	NT	NT	NT	NT	6	NT	110	NA	NA
Pyrene	678GP001	NT	NT	NT	NT	2.6	NT	110	NA	NA
	678GP002	NT	NT	NT	NT	2.8	NT			
Inorganics										
Aluminum (Al)	678GW001	ND	31.7	ND	26.2	NT	NT	3700	NL	1440
	678GW002	171	204	ND	69.1	NT	NT			
Arsenic (As)	678GW001	ND	ND	11.6	ND	NT	NT	0.045	50	23
	679GW001	5.3	ND	ND	ND	NT	NT			
Barium (Ba)	678GW001	11.3	10.1	ND	14.9	NT	NT	260	2000	110
	678GW002	ND	17.6	ND	21.8	NT	NT			
Cadmium (Cd)	678GW001	0.3	ND	ND	ND	NT	NT	1.8	5	NA
Chromium	678GW001	1.6	2.7	ND	ND	NT	NT	18	100	14.3
(Cr) (total)	678GW002	1.7	1.3	ND	ND	NT	NT			
Lead (Pb)	678GW001	2.6	ND	ND	ND	NT	NT	15	15	4.4
	678GW002	3.5	ND	ND	ND	NT	NT			

Table 10.4.8
AOC 678/679
Analytes Detected in Shallow Groundwater (μg/L)

Parameters	Location	1st Round Conc.	2nd Round Conc.	3rd Round Conc.	4th Round Conc.	5th Round Conc.	6th Round Conc.	Tap Water RBC*	MCL/ SMCL	Shallow Background
Manganese (Mn)	678GW001	245	338.5	663.5	126	NT	NT	73	NL	5430
	678GW002	150	220	ND	187	NT	NT			
	679GW001	42.3	ND	ND	ND	NT	NT			
Nickel (Ni)	678GW001	2.5	ND	1.9	ND	NT	NT	73	100	13.3
	678GW002	1.5	ND	ND	ND	NT	NT			
Selenium (Se)	678GW001	ND	ND	ND	3.1	NT	NT	18	50	ND
Vanadium (V)	678GW001	1	ND	ND	ND	NT	NT	26	NL	14
Zinc (Zn)	678GW002	11.5	ND	ND	ND	NT	NT	1100	NL	24.4

Notes:

* = Tap Water RBCs (THQ=0.1) from *Risk-Based Concentration Table* (USEPA, October 22, 1997), and MCLs/SMCLs from *Drinking Water Regulations and Health Advisories* (USEPA, 1996e)
Bolded concentrations exceed the RBC and the zone background
All background values for Zone I are based on twice the means of the grid sample concentrations. Background values for the groundwater are based on two sampling rounds in two wells at each depth
NL = Not listed
ND = Not detected
NT = Not taken
NA = Not applicable
RBC = Risk-based concentration
MCL = Maximum Concentration Levels
SMCL = Secondary Maximum Concentration Levels

Volatile Organic Compounds in Groundwater

Five VOCs were detected in shallow groundwater samples. These detections were all in round five from the geoprobe samples. Chlorobenzene was detected once and exceeded its tap-water RBC (3.5 μg/L) with a result of 6.5 μg/L in sample 678GP00201. The remaining VOCs were below their respective tap-water RBC.

Two VOCs, acetone and chlorobenzene, were detected in shallow groundwater at GDI014 in rounds two and three respectively. All concentrations were far below the tap-water RBCs.

Four VOCs, acetone, carbon disulfide, chlorobenzene, and 1,2-dichloroethene (total), were detected in deep groundwater samples from the geoprobe samples in round five. Once again chlorobenzene exceeded its tap-water RBC at 8.95 ng/L in 678GP00202. All other VOCs were below their respective tap-water RBCs.

Five VOCs (2-butanone (MEK), acetone, carbon disulfide, methylene chloride, and chloroethane) were detected in deep groundwater at deep grid well GDI14D. Only one, chloroethane, exceeded its tap-water-RBC.

Semivolatile Organic Compounds in Groundwater

Ten SVOCs were detected in shallow groundwater during the fifth round of sampling. One SVOC, benzo(a)anthrancene, exceeded its tap-water RBC.

Eleven SVOCs were detected in shallow groundwater at GDI014. Three (1,2,3,4-tetrachlorobenzene, dibenzofuran, and pentachlorophenol) exceeded their tap-water RBC.

In accordance with recent cPAH guidance and Section 7 of this report, BEQs were calculated for cPAHs at AOC 678/679. The BEQ for shallow groundwater sample 678GP002 is 0.063 μg/L, which exceeds the RBC for benzo(a) pyrene of 0.0092 μg/L.

Eight SVOCs were detected in deep groundwater geoprobe samples. All SVOCs were detected in the fifth round of sampling and none exceeded its tap-water RBC. Three SVOCs, benzoic acid, diethylphthalate, and phenol, were detected in deep groundwater at deep grid well GDI14D. All three SVOCs were far below their tap-water RBC.

Pesticides and PCBs in Groundwater

No pesticides or PCBs were detected in shallow groundwater samples collected at AOC 678/679.

Aroclor-1260 was detected in the shallow grid well GDI014. Aroclor-1260 was detected at 1.30 μg/L, exceeding its RBC of 0.0087 μg/L. No pesticides or PCBs were detected in the deep groundwater sample from GDI14D.

Inorganics in Groundwater

Eleven metals were detected in AOC 678/679 shallow groundwater samples. None of the detections exceeded the RBC and shallow background values.

In all, ten metals were detected during four groundwater sampling rounds at shallow grid well GDI014. All concentrations were far below their respective tap-water RBCs and shallow groundwater background concentrations. Ten metals were also detected during the four groundwater sampling rounds at deep grid well GDI14D. Again, all concentrations were far below their MCLs and/or deep background values.

10.4.5 Fate and Transport Assessment

AOC 678 is the former site of Building 2-V, the Firefighter School, northeast of Building NS-1 in the northeastern portion of the southern peninsula. The firefighting school was reportedly constructed in 1947 and demolished circa 1955. Controlled fires may have been ignited and extinguished onsite for firefighter training. No other details regarding the design features or operating practices were available. Currently, the area is a paved parking lot.

AOC 679 consists of a former wash rack noted on early CNC maps from the 1930s and 1940s. This former wash rack was located off the west edge of Building NS-1. No information is available regarding the design features, years of operation, or operating practices for the wash rack. It is assumed that activities at this unit included washing or cleaning of equipment in an external wash area.

Environmental media sampled as part of the as AOC 678/679 investigation include surface soil, subsurface soil, and shallow groundwater. Potential constituent migration pathways investigated include soil to groundwater, groundwater migration, and emission of volatiles from surface soil to air. Additionally, an effort to preliminarily address the issue of discharge to surface water receptors was made. This assessment is intended to serve as a qualitative analysis using the analytical data for these media coupled with the current understanding of hydrogeological conditions at the site.

10.4.5.1 Soil-to-Groundwater Cross-Media Transport

Tables 10.4.9 and 10.4.10 compare maximum detected organic and inorganic constituent concentrations respectively in surface soil and subsurface soil samples to risk-based soil screening levels considered protective of groundwater. To provide a conservative screen, generic soil screening levels are used; leachate entering the aquifer is assumed to be diluted by a ratio of 10:1, with no attenuation of constituents in soil (DAF=10).

Table 10.4.9
Organic Chemicals Detected in Surface Soil, Subsurface Soil, Sediment, and Shallow Groundwater
Comparison to Cross-media SSLs, Tap Water RBCs, and Saltwater Surface Water Chronic Screening Levels
AOC 678/679
Charleston Naval Complex
Charleston, South Carolina

	Maximum Concentration				Screening Concentration									
Parameter	Surface Soil	Subsurface Soil	Sediment	Shallow GW	Soil to GW SSL	Soil to Air SSL	Tap Water RBC	Saltwater Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Volatil-ization Potential	Ground-water Migration Concern	Surface Water Migration Concern
Volatile Organic Compounds														
Acetone	50	29	NA	28	8000	1.0E+08	3700	NA	UG/KG	UG/L	NO	NO	NO	NO
Carbon disulfide	ND	ND	NA	0.56	16000	720000	1000	NA	UG/KG	UG/L	NO	NO	NO	NO
Chlorobenzene	ND	ND	NA	6.5	700	130000	35	105	UG/KG	UG/L	NO	NO	NO	NO
1,2-Dichloroethene (total)	ND	ND	NA	0.84	200	1100000	55	NA	UG/KG	UG/L	NO	NO	NO	NO
Methylene chloride c	ND	ND	NA	1	10	13000	4.1	2560	UG/KG	UG/L	NO	NO	NO	NO
Toluene	4	7	NA	ND	6000	650000	750	37	UG/KG	UG/L	NO	NO	NO	NO
Trichlorotrifluoroethane (Freon 113)	4	ND	NA	ND	NA	2400000	59000	NA	UG/KG	UG/L	NO	NO	NO	NO
Semivolatile Organic Compounds														
Acenaphthene	ND	ND	ND	7	290000	NA	2200	9.7	UG/KG	UG/L	NO	NO	NO	NO
Acetophenone	240	ND	NA	ND	0.12 a	NA	0.042	NA	UG/KG	UG/L	YES	NO	NO	NO
Anthracene	46	ND	NA	1	5900000	NA	11000	NA	UG/KG	UG/L	NO	NO	NO	NO
Benzo(g,h,i)perylene	110	ND	NA	ND	1.2E+08 a	NA	1500	NA	UG/KG	UG/L	NO	NO	NO	NO
Benzo(a)pyrene Equivalents	253	128	NA	0.063	1600 a	NA	0.0092	NA	UG/KG	UG/L	NO	NO	YES	NO
Benzo(a)anthracene c	180	75	NA	0.62	800	NA	0.092	NA	UG/KG	UG/L	NO	NO	YES	NO
Benzo(a)pyrene c	200	96	NA	ND	4000	NA	0.0092	NA	UG/KG	UG/L	NO	NO	NO	NO
Benzo(b)fluoranthene c	240	220	NA	ND	2500	NA	0.092	NA	UG/KG	UG/L	NO	NO	NO	NO
Benzo(k)fluoranthene c	170	230	NA	ND	25000	NA	0.92	NA	UG/KG	UG/L	NO	NO	NO	NO
Chrysene c	200	110	NA	0.81	80000	NA	9.2	NA	UG/KG	UG/L	NO	NO	NO	NO
Indeno(1,2,3-cd)pyrene c	97	ND	NA	ND	7000	NA	0.092	NA	UG/KG	UG/L	NO	NO	NO	NO
Di-n-butylphthalate	80	220	NA	ND	2300000	2300000	3700	3.4	UG/KG	UG/L	NO	NO	NO	NO
bis(2-Ethylhexyl)phthalate (BEHP) c	240	ND	NA	1	1800000	31000000	4.8	NA	UG/KG	UG/L	NO	NO	NO	NO
Ethyl methacrylate	40	ND	NA	ND	1500 a	NA	550	NA	UG/KG	UG/L	NO	NO	NO	NO
Fluoranthene	330	120	NA	3	2100000	NA	1500	1.6	UG/KG	UG/L	NO	NO	NO	YES
Isodrin	1000	ND	NA	ND	NA	NA	NA	NA	UG/KG	UG/L	NO	NO	NO	NO
Methapyrilene	50	ND	NA	ND	NA	NA	NA	NA	UG/KG	UG/L	NO	NO	NO	NO
1-Methylnaphthalene	39	ND	NA	ND	72000 a	NA	1500	NA	UG/KG	UG/L	NO	NO	NO	NO
2-Methylnaphthalene	110	ND	NA	ND	230000 a	NA	1500	23.5	UG/KG	UG/L	NO	NO	NO	NO
Naphthalene	68	ND	NA	4.8	42000	NA	1500	23.5	UG/KG	UG/L	NO	NO	NO	NO
Phenanthrene	220	67	NA	6	660000 a	NA	1100	NA	UG/KG	UG/L	NO	NO	NO	NO
Pyrene	330	100	NA	2.8	2100000	NA	1100	NA	UG/KG	UG/L	NO	NO	NO	NO
Pesticides/PCBs														
Aroclor-1260 c	ND	27	NA	ND	1000	1000	0.033	0.03	UG/KG	UG/L	NO	NO	NO	NO
beta-BHC (beta-HCH) c	2	ND	NA	ND	1.3	1E+09	0.037	NA	UG/KG	UG/L	YES	NO	NO	NO
4,4'-DDD c	170	42	NA	ND	8000	NA	0.28	0.025	UG/KG	UG/L	NO	NO	NO	NO
4,4'-DDE c	480	28	NA	ND	27000	NA	0.2	0.14	UG/KG	UG/L	NO	NO	NO	NO
4,4'-DDT c	86	4.6	NA	ND	16000	1E+09	0.2	0.001	UG/KG	UG/L	NO	NO	NO	NO

Table 10.4.9
Organic Chemicals Detected in Surface Soil, Subsurface Soil, Sediment, and Shallow Groundwater
Comparison to Cross-media SSLs, Tap Water RBCs, and Saltwater Surface Water Chronic Screening Levels
AOC 678/679
Charleston Naval Complex
Charleston, South Carolina

Parameter	Maximum Concentration Surface Soil	Subsurface Soil	Sediment	Shallow GW	Screening Concentration Soil to GW SSL	Soil to Air SSL	Tap Water RBC	Saltwater Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Volatilization Potential	Groundwater Migration Concern	Surface Water Migration Concern
Endrin	12	ND	NA	ND	500	NA	11	0.0023	UG/KG	UG/L	NO	NO	NO	NO
Endrin aldehyde	1.3	ND	NA	ND	340 a	NA	11	NA	UG/KG	UG/L	NO	NO	NO	NO
Methoxychlor	22	4	NA	ND	80000	NA	180	0.03	UG/KG	UG/L	NO	NO	NO	NO
Organophosphate Pesticides														
Famphur	ND	5.7	NA	ND	27000 b	110000	220	0.178	UG/KG	UG/L	NO	NO	NO	NO
Methyl parathion	3.9	ND	NA	ND	150 a	28000	9.1	NA	UG/KG	UG/L	NO	NO	NO	NO
Phorate	10	ND	NA	ND	820 a	NA	7.3	NA	UG/KG	UG/L	NO	NO	NO	NO
Herbicides														
2,4,5-T	ND	3.4	NA	ND	990 a	NA	370	NA	UG/KG	UG/L	NO	NO	NO	NO
Organotin														
Tributyltin	ND	2.7	NA	ND	NA	NA	11	0.01	UG/KG	UG/L	NO	NO	NO	NO
Dioxin Compounds														
2,3,7,8-TCDD equivalents (TEQs) c	3.71	0.104	NA	ND	1600 a	NA	0.45	10	NG/KG	PG/L	NO	NO	NO	NO
123678-HxCDD c	2.06	ND	NA	ND	4100 a	NA	4.5	NA	NG/KG	PG/L	NO	NO	NO	NO
123789-HxCDD c	0.741	ND	NA	ND	4100 a	NA	4.5	NA	NG/KG	PG/L	NO	NO	NO	NO
1234678-HpCDD c	147	2.1	NA	ND	108000 a	NA	45	NA	NG/KG	PG/L	NO	NO	NO	NO
OCDD c	1700	33	NA	ND	1080000 a	NA	450	NA	NG/KG	PG/L	NO	NO	NO	NO
123478-HxCDF c	1.94	ND	NA	ND	216000 a	NA	4.5	NA	NG/KG	PG/L	NO	NO	NO	NO
123789-HxCDF c	ND	0.492	NA	ND	216000 a	NA	4.5	NA	NG/KG	PG/L	NO	NO	NO	NO
1234678-HpCDF c	5.94	ND	NA	ND	54000 a	NA	45	NA	NG/KG	PG/L	NO	NO	NO	NO
OCDF c	8.17	0.477	NA	ND	540000 a	NA	450	NA	NG/KG	PG/L	NO	NO	NO	NO

Notes:
Sources of screening concentrations appear in Table 5.5
Explanations of fate and transport screening procedures appear in Section 6.2.
Frequency and range of detections, average detected concentrations, and number of screening concentration exceedances appear in Tables 10.4.2 and 10.4.6.

a - Calculated soil to groundwater SSL value (See Table 6.2)
b - Based on surrogate compound; see Table 5.5
c - Carcinogenic
GW - Groundwater

NA - Not applicable/not available
ND - Not detected
RBC - Risk-based concentration
SSL - Soil screening level

NG/KG - Nanograms per kilogram
UG/KG - Micrograms per kilogram
PG/L - Picograms per liter
UG/L - Micrograms per liter

Table 10.4.10
Inorganic Chemicals Detected in Surface Soil, Subsurface Soil, Sediment, and Shallow Groundwater
Comparison to Cross-media SSLs, Tap Water RBCs, Saltwater Surface Water Chronic Screening Levels, and Background Values
AOC 678/679
Charleston Naval Complex
Charleston, South Carolina

Parameter	Maximum Concentration				Screening Concentration											
	Surface Soil	Subsurface Soil	Sediment	Shallow GW	Soil to GW SSL	Soil Background	Soil to Air SSL	Tap Water RBC	Shallow GW Background	Saltwater Surf. Wtr Chronic	Soil Units	Water Units	Leaching Potential	Fugitive Particulate Inhalation Concern	Ground-water Migration Concern	Surface Water Migration Concern
Inorganic Chemicals																
Aluminum (Al)	7580	9150	NA	204	560000 a	27400	NA	37000	1440	NA	MG/KG	UG/L	NO	NO	NO	NO
Antimony (Sb)	0.39	ND	NA	ND	2.7	ND	NA	15	NA	NA	MG/KG	UG/L	NO	NO	NO	NO
Arsenic (As) c	7.4	7	NA	11.6	15	21.6	750	0.045	23	36	MG/KG	UG/L	NO	NO	NO	NO
Barium (Ba)	98.5	58.6	NA	21.8	820	54.2	690000	2600	110	NA	MG/KG	UG/L	NO	NO	NO	NO
Beryllium (Be)	0.41	0.52	NA	ND	32	0.95	1300	73	1.1	NA	MG/KG	UG/L	NO	NO	NO	NO
Cadmium (Cd)	0.5	0.44	NA	0.3	4	0.61	1800	18	NA	9.3	MG/KG	UG/L	NO	NO	NO	NO
Chromium (Cr) (total)	116	28.3	NA	2.65	19	51.3	270	180	14.3	50	MG/KG	UG/L	YES	NO	NO	NO
Cobalt (Co)	10.7	4.6	NA	ND	990 a	5.8	NA	2200	2.2	NA	MG/KG	UG/L	NO	NO	NO	NO
Copper (Cu)	15.7	67.3	NA	ND	5600 a	240	NA	1500	4.4	2.9	MG/KG	UG/L	NO	NO	NO	NO
Lead (Pb)	31	468	NA	3.5	400	203	400	15	4.4	8.5	MG/KG	UG/L	YES	NO	NO	NO
Manganese (Mn)	81.4	338	NA	663	480 a	419	NA	730	5430	NA	MG/KG	UG/L	NO	NO	NO	NO
Mercury (Hg)	0.29	3.1	NA	ND	1	0.47	10	11	NA	0.025	MG/KG	UG/L	YES	NO	NO	NO
Nickel (Ni)	9.3	13.3	NA	2.5	65	23.9	13000	730	13.3	8.3	MG/KG	UG/L	NO	NO	NO	NO
Selenium (Se)	0.82	0.85	NA	3.1	2.6	1.77	NA	180	ND	71	MG/KG	UG/L	NO	NO	NO	NO
Tin (Sn)	2.42	2.4	NA	ND	5500 a	7.5	NA	22000	NA	NA	MG/KG	UG/L	NO	NO	NO	NO
Vanadium (V)	32.3	18.2	NA	1	3000	113	NA	260	14	NA	MG/KG	UG/L	NO	NO	NO	NO
Zinc (Zn)	87.6	189	NA	11.5	6200	206	NA	11000	24.4	86	MG/KG	UG/L	NO	NO	NO	NO

Notes:
Sources of screening concentrations appear in Table 5.6
Explanations of fate and transport screening procedures appear in Section 6.2.
Frequency and range of detections, average detected concentrations, and number of screening concentration exceedances appear in Tables 10.4.3 and 10.4.7.

Background values for soil are shown for comparison purposes only.
Maximum groundwater concentrations are screened against the greater of tap water RBCs or corresponding background values to determine groundwater migration concern.

a - Calculated soil to groundwater SSL value (See Table 6.2)
c - Carcinogenic
GW - Groundwater
NA - Not available/Not applicable
ND - Not detected
RBC - Risk-based concentration
SSL - Soil screening level
MG/KG - Milligrams per kilogram
UG/L - Micrograms per liter

Two organic compounds – acetaphenone and beta-BHC – were present in surface soil above their respective screening values. There were no organic exceedances in subsurface soil. Acetaphenone was detected in only one sample (679SB00801), while beta-BHC was detected in only two. Figure 10.4.2 presents the beta-BHC concentrations detected at AOC 678/679. The limited occurrence of these compounds is indicative of very little residual mass in soil available to leach via this pathway. The sources of these compounds in soil are not likely to be directly associated with past site activities (hydrocarbon burning as part of firefighting activities). Additionally, neither of these compounds was detected in groundwater. Consequently the pathway is considered invalid with respect to organics.

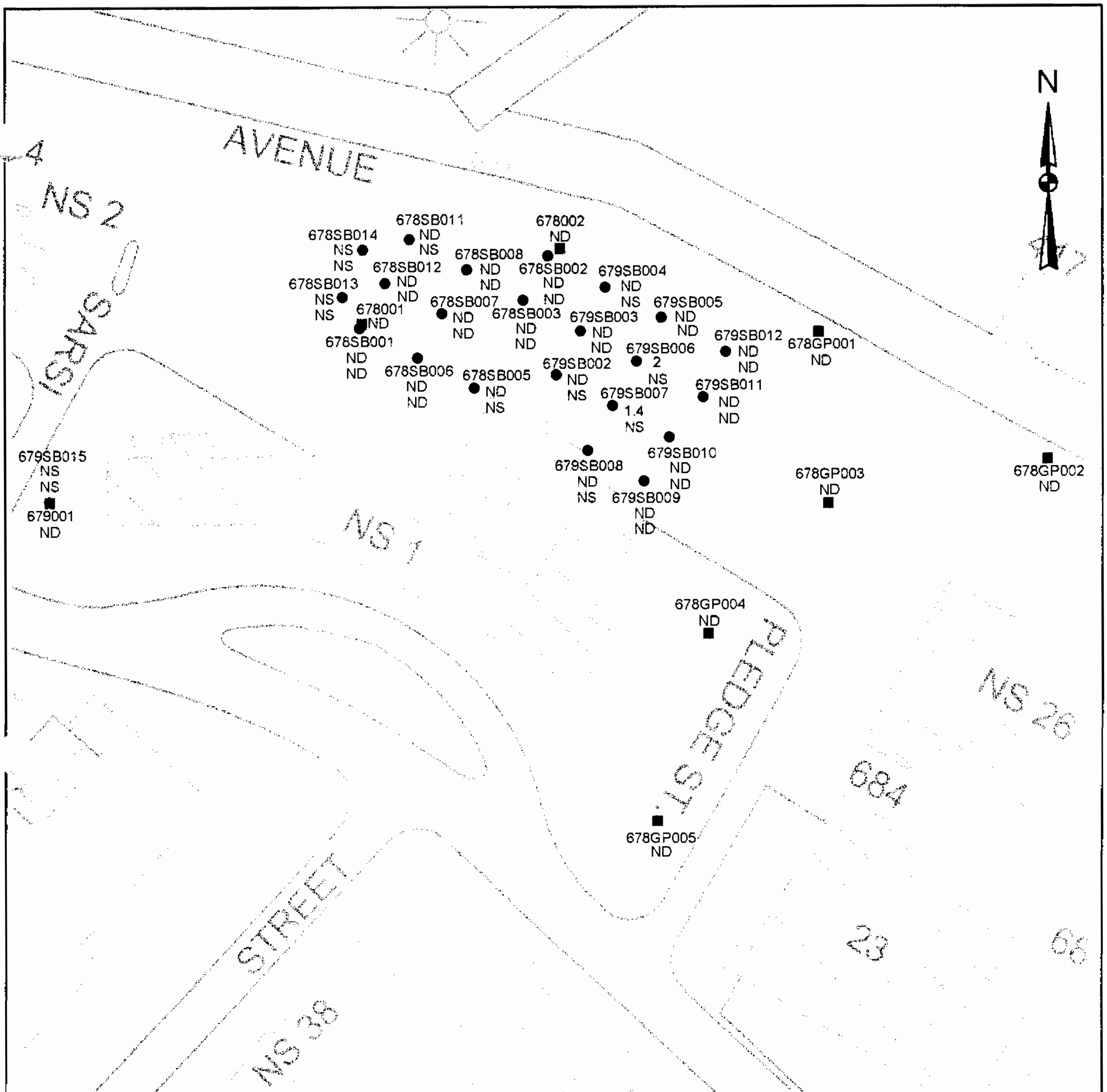
Three inorganics – chromium, lead and mercury – were present in soil above their respective screening values. Both lead and mercury exhibit an increase in concentration in subsurface soil, are above the zone background in subsurface soil, and are below their SSLs in surface soil. Conversely, chromium exhibited a decrease in concentration in subsurface soil. The reason for lead and mercury to be relatively enriched with depth is unknown, but would require some mobilizing agent having a relatively low pH (something not likely directly associated with site activities). However, many of the detected metals exhibited similar trends. It is both possible and probable that these trends are a result of natural variation in the site soil, which can occur in both native and non-native material. Mercury was not detected in site groundwater, whereas chromium and lead were widely detected, therefore validating the migration pathway. Figures 10.4.3, 10.4.4, and 10.4.5 present the concentrations of chromium, lead, and mercury respectively detected at AOC 6778/679. However, none of these detections were above groundwater screening values, and the pathway is not expected to be significant with respect to them.

10.4.5.2 Groundwater Migration and Surface Water Cross-Media Transport

Tables 10.4.9 and 10.4.10 compare maximum detected organic and inorganic constituent concentrations respectively in shallow groundwater samples to risk-based concentrations for drinking water, and to chronic ambient saltwater quality criteria values for the protection of aquatic life (saltwater surface water chronic screening values). For inorganics, maximum concentrations in groundwater are screened against the greater of (a) risk-based drinking water concentrations or (b) corresponding background reference concentrations for groundwater, as well as to the saltwater surface water chronic values. To provide a conservative screening, no attenuation or dilution of constituents in groundwater is assumed before comparison to the relevant standards. It should be noted at the beginning of this discussion that the risk-based pathway for shallow groundwater is currently an invalid pathway simply because there is no human consumption of the groundwater, e.g. there is no end-use receptor. This comparison is made for screening only, and to develop strategies for long-term management of the groundwater should an area containing deleterious levels be identified.

Benzo(a)pyrene equivalents (BEQs), and in particular benzo(a)anthracene, were present above their RBC values in groundwater. Both benzo(a)anthracene and BEQs were detected in soil, but at concentrations less than their SSL. Detection of benzo(a)anthracene was very limited however, (only in one geoprobe water sample during the fifth sampling round) and it was actually nondetect during the sixth sampling round at well 679001. The source of these constituents in groundwater may be associated with past site activities, given that wastes of concern include petroleum, used oil, and grease. Even though detections are not consistent nor at notably high levels, the migration pathway is considered valid, but is not significant due to non-use of the resource. Figures 10.4.6 and 10.4.7 present the detected concentrations of BEQ, and benzo(a)anthracene, respectively, at AOC 678/679.

One organic - flouranthene - was present in groundwater above its screening value for surface water migration. It was detected in two of five geoprobe groundwater samples during the fifth sampling round, but only slightly exceeded its screening criteria. It was present in soil below its SSL, and the source may well be associated with past site activities. Figure 10.4.8 presents the



LEGEND

■	MONITORING WELL LOCATION
●	ZONE I SOIL BORING LOCATION
12.30	ZONE I SURFACE SOIL CONC. (UG/KG)
12.30	ZONE I SUBSURFACE SOIL CONC. (UG/KG)
12.30	MAXIMUM QUARTERLY GW CONC. (UG/L)
NS	NO SAMPLE TAKEN
ND	NON DETECT

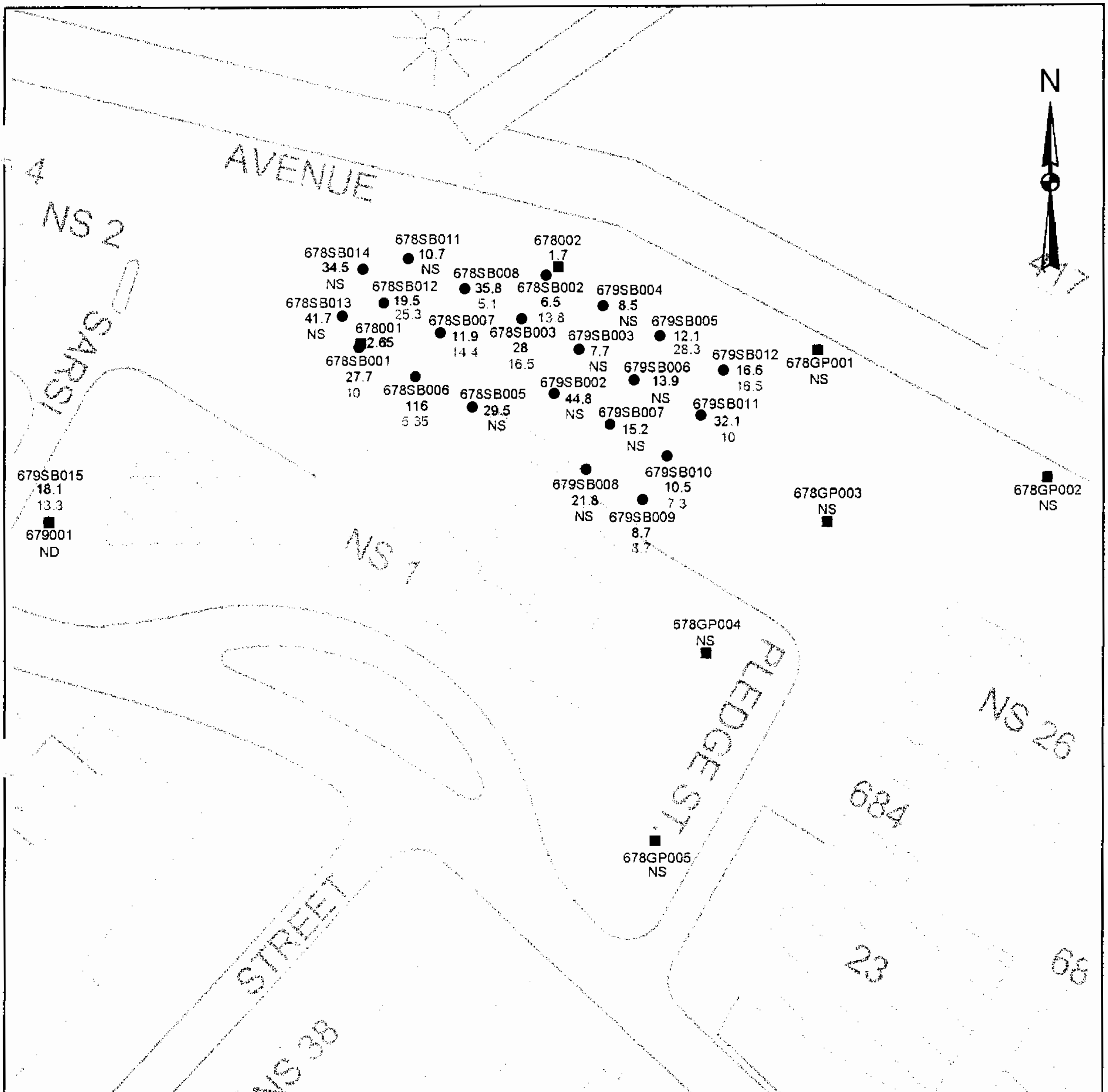
SCALE

0 50 100 150 200 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.4.2
ZONE I
AOC 678/679
BETA-BHC
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=NA RBC=350 UG/KG SSL=1.3 UG/KG



LEGEND

■	MONITORING WELL LOCATION
●	ZONE I SOIL BORING LOCATION
12.30	ZONE I SURFACE SOIL CONC. (MG/KG)
12.30	ZONE I SUBSURFACE SOIL CONC. (MG/KG)
12.30	MAXIMUM QUARTERLY GW CONC. (UG/L)
NS	NO SAMPLE TAKEN
ND	NON DETECT

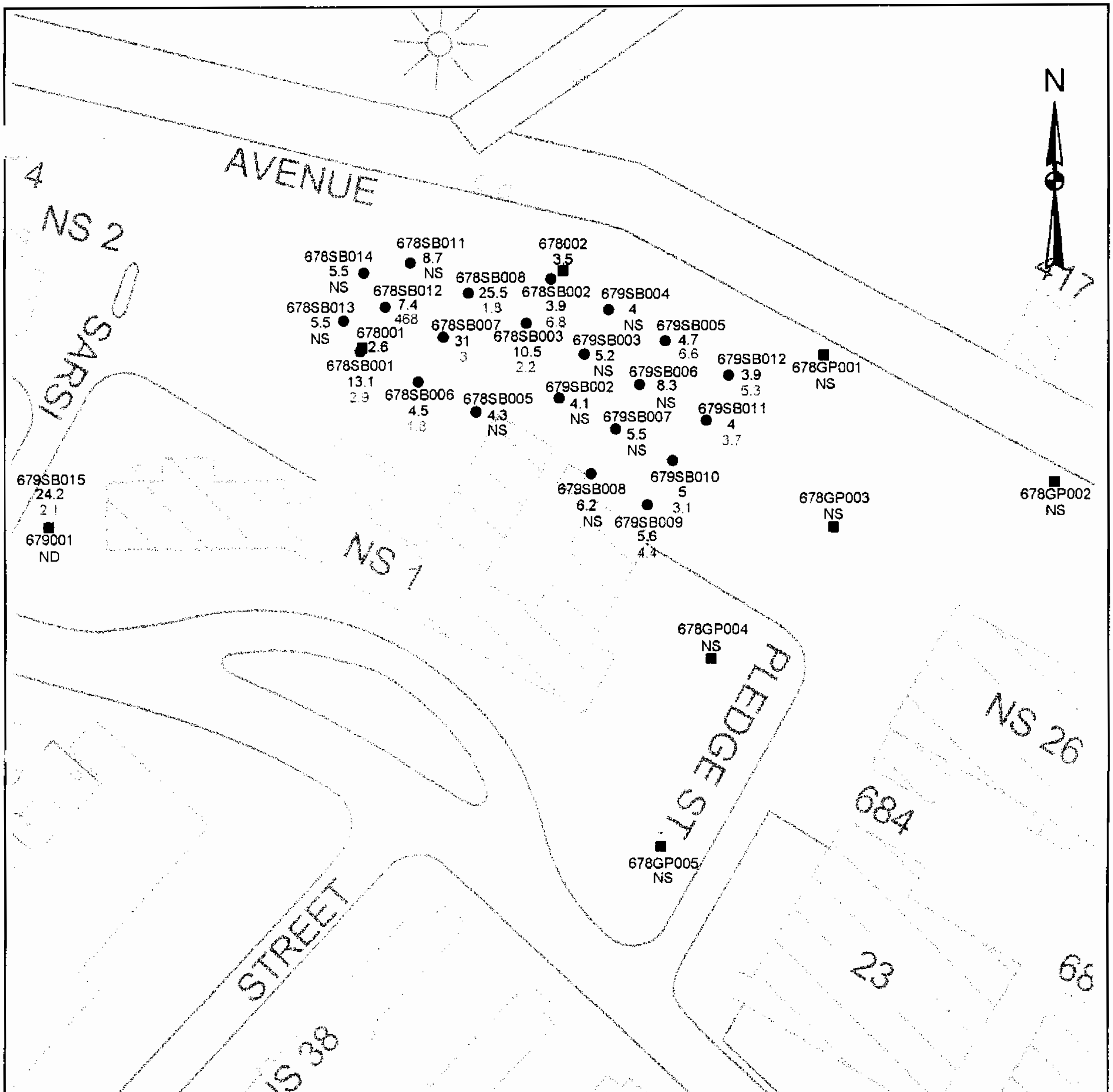
SCALE

0 50 100 150 200 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.4.3
ZONE I
AOC 678/679
CHROMIUM
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=NA RBC=39 MG/KG SSL=19 MG/KG



LEGEND

■	MONITORING WELL LOCATION
●	ZONE I SOIL BORING LOCATION
12.30	ZONE I SURFACE SOIL CONC. (MG/KG)
12.30	ZONE I SUBSURFACE SOIL CONC. (MG/KG)
12.30	MAXIMUM QUARTERLY GW CONC. (UG/L)
NS	NO SAMPLE TAKEN
ND	NON DETECT

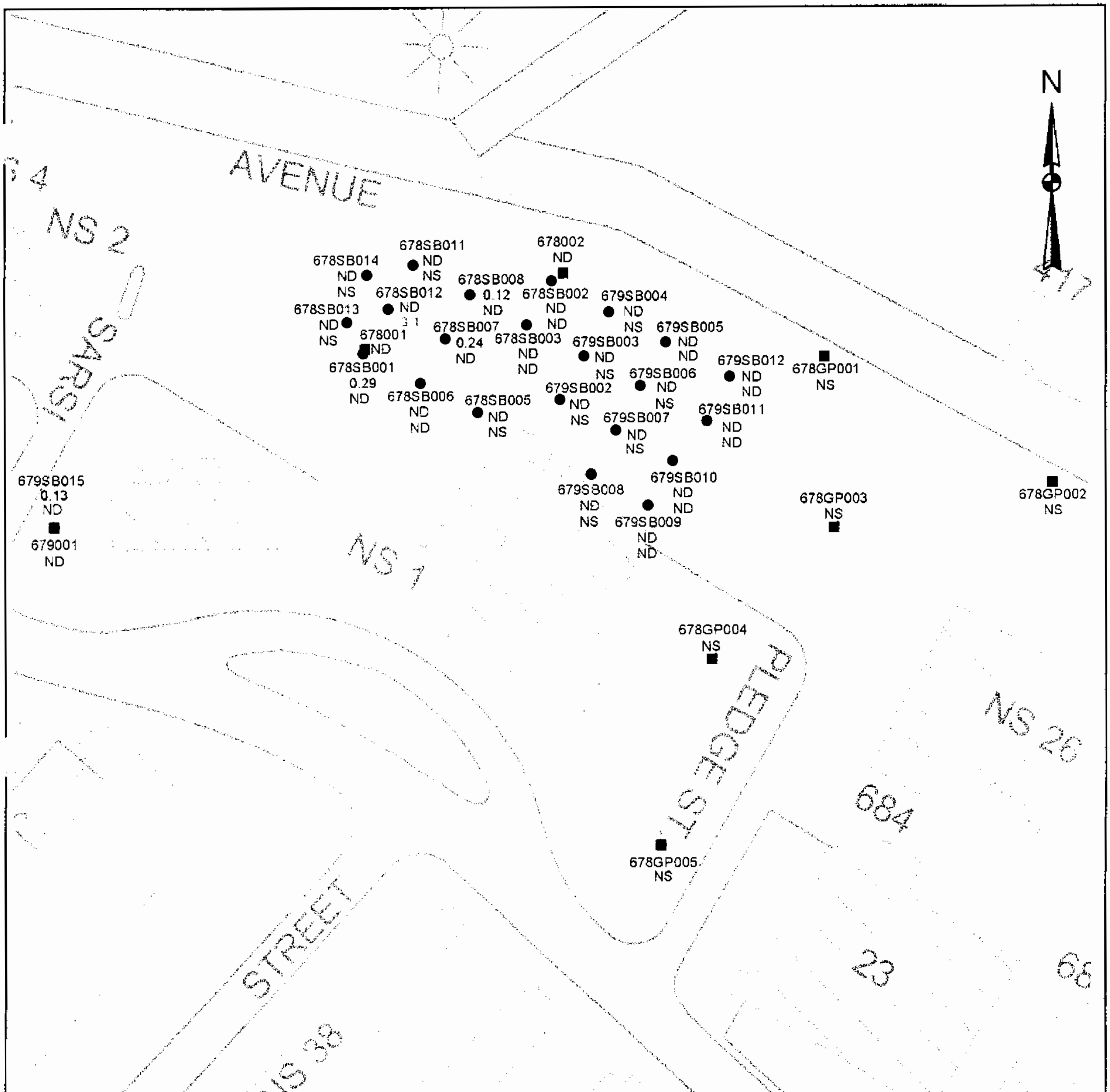
SCALE

0 50 100 150 200 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.4.4
ZONE I
AOC 678/679
LEAD
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=NA RBC=400 MG/KG SSL=400 MG/KG



LEGEND

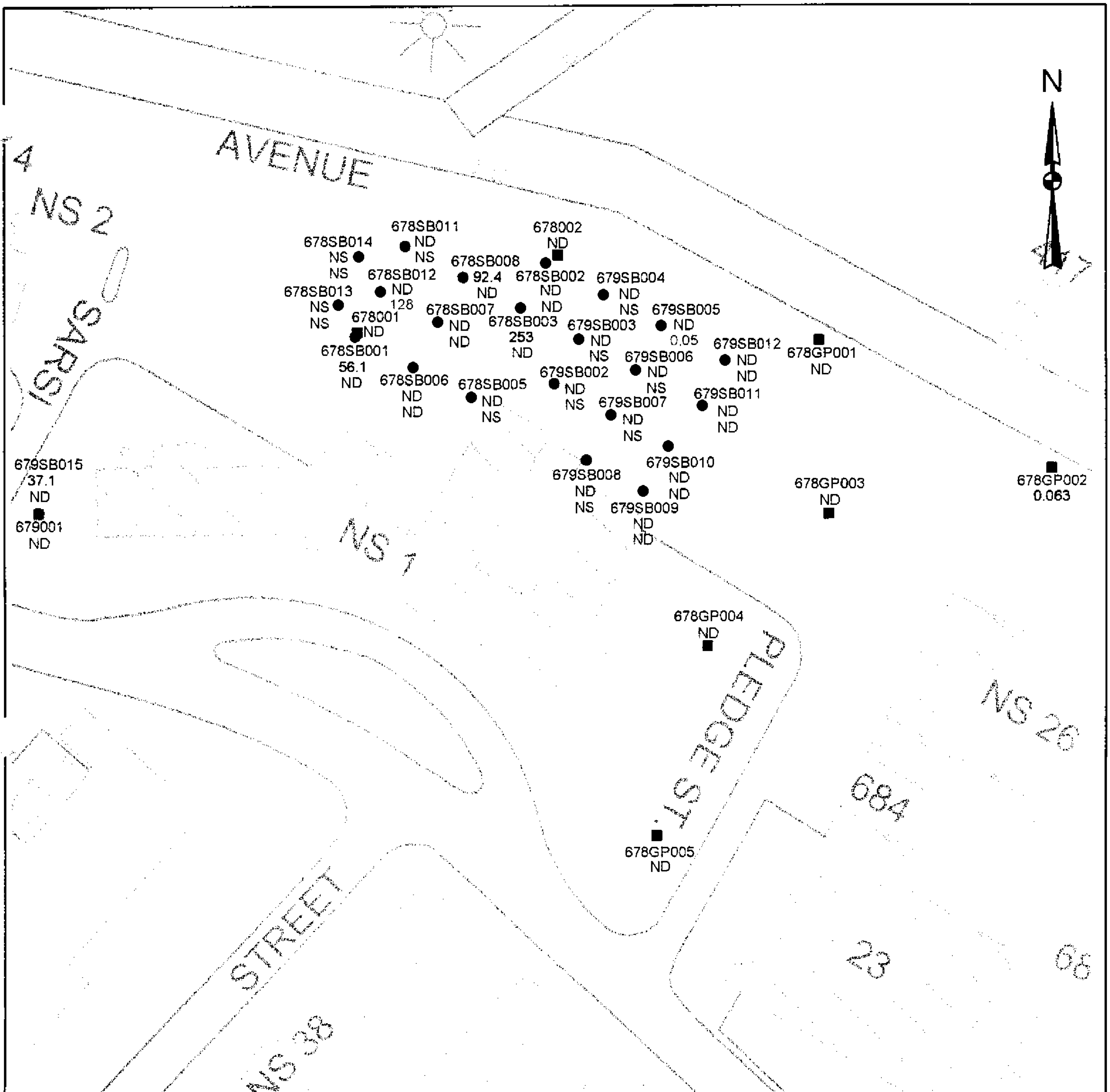
■ MONITORING WELL LOCATION
● ZONE I SOIL BORING LOCATION
12.30 ZONE I SURFACE SOIL CONC. (MG/KG)
12.30 ZONE I SUBSURFACE SOIL CONC. (MG/KG)
12.30 MAXIMUM QUARTERLY GW CONC. (UG/L)
NS NO SAMPLE TAKEN
ND NON DETECT

SCALE
0 50 100 150 200 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.4.5
ZONE I
AOC 678/679
MERCURY
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=2 UG/L RBC=2.3 MG/KG SSL=1 MG/KG



LEGEND

■	MONITORING WELL LOCATION
●	ZONE I SOIL BORING LOCATION
12.30	ZONE I SURFACE SOIL CONC. (UG/KG)
12.30	ZONE I SUBSURFACE SOIL CONC. (UG/KG)
12.30	MAXIMUM QUARTERLY GW CONC. (UG/L)
NS	NO SAMPLE TAKEN
ND	NON DETECT

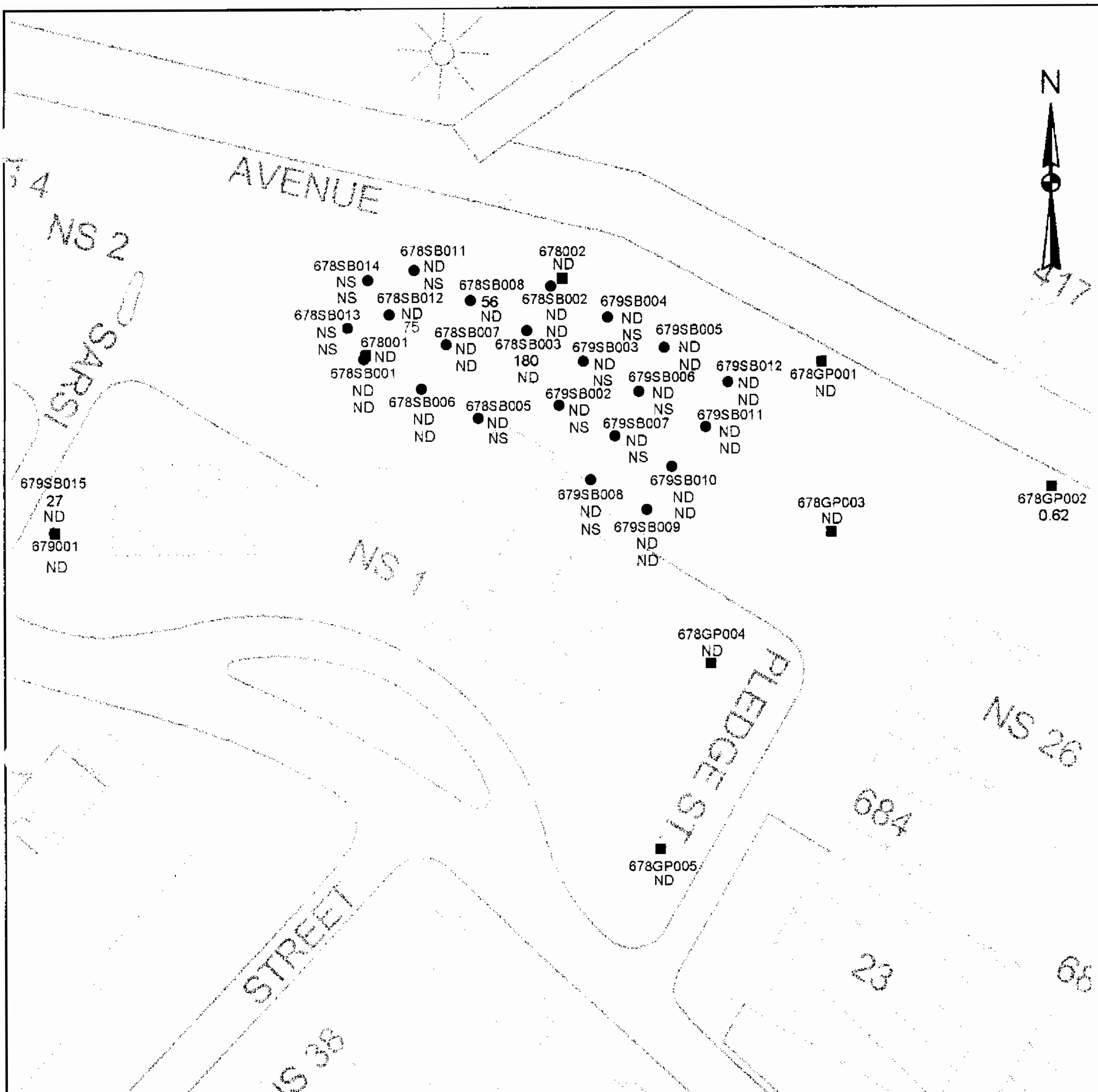
SCALE

0 50 100 150 200 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.4.6
ZONE I
AOC 678/679
BEQs
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=.2 UG/L RBC=87 UG/KG SSL=1600 UG/KG



LEGEND

■	MONITORING WELL LOCATION
●	ZONE I SOIL BORING LOCATION
12.30	ZONE I SURFACE SOIL CONC. (UG/KG)
12.30	ZONE I SUBSURFACE SOIL CONC. (UG/KG)
12.30	MAXIMUM QUARTERLY GW CONC. (UG/L)
NS	NO SAMPLE TAKEN
ND	NON DETECT

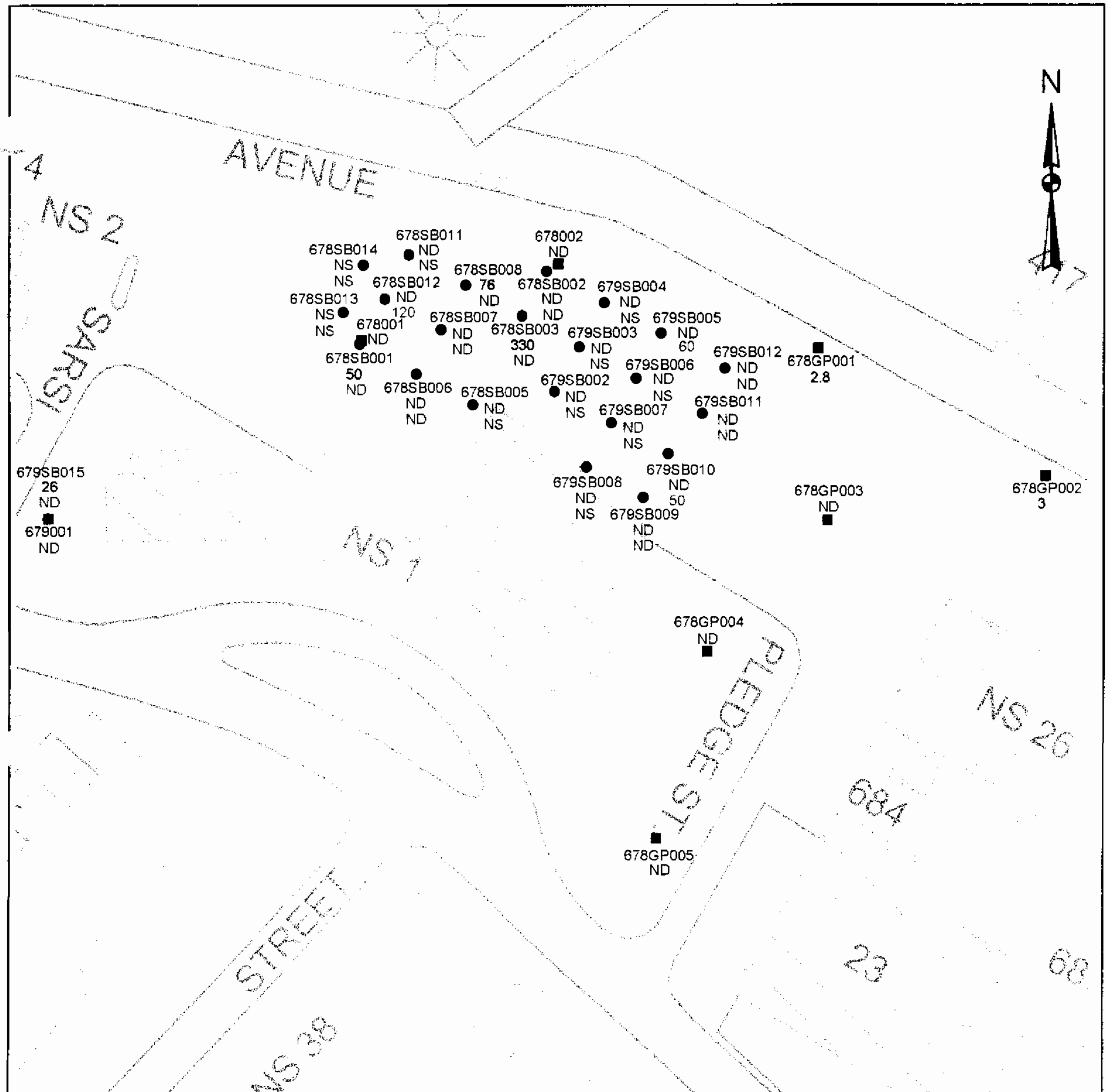
SCALE

0 50 100 150 200 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.4.7
ZONE I
AOC 678/679
BENZO(A)ANTHRACENE
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=NA RBC=870 UG/KG SSL=800 UG/KG



LEGEND

■	MONITORING WELL LOCATION
●	ZONE I SOIL BORING LOCATION
12.30	ZONE I SURFACE SOIL CONC. (UG/KG)
12.30	ZONE I SUBSURFACE SOIL CONC. (UG/KG)
12.30	MAXIMUM QUARTERLY GW CONC. (UG/L)
NS	NO SAMPLE TAKEN
ND	NON DETECT

SCALE

0 50 100 150 200 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.4.8
ZONE I
AOC 678/679
FLUORANTHENE
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=NA RBC=310000 UG/KG SSL=2100000 UG/KG

detections of flouranthene at AOC 678/679. The Cooper River is a potential receptor, thus validating the pathway. However, the relatively low detected concentrations of flouranthene, coupled with expected dilution upon discharge to the Cooper River, suggest that the pathway is not expected to be significant.

10.4.5.3 Soil to Air Cross-Media Transport

No surface soil parameters were present above their respective screening values for the soil to air pathway, thus the pathway is considered invalid for this AOC.

10.4.5.4 Fate and Transport Summary

Acetaphenone, beta-BHC, chromium, lead, and mercury were present in soil above their respective SSLs. Neither of the organics was detected in site groundwater, thus the pathway is considered invalid with respect to them. Lead and mercury exhibited an increase in concentration with depth, a trend noted in many of the detected metals. Conversely, chromium exhibited a decrease with depth. Because the site history does not include the use of potential mobilizing agents for metals, it is expected that these trends with depth represent natural variations within the site soil. Both lead and chromium were detected in groundwater, thus the pathway is considered valid with respect to them.

BEQs and in particular benzo(a)anthracene, were present in site groundwater at concentrations above their respective RBCs. Detection of benzo(a)anthracene was very limited, however, and it was actually nondetected during the most recent sampling round. Even though detections are not consistent in terms of frequency or concentration, the pathway is considered valid but not significant due to non-use of the resource.

Flouranthene was detected in two of five geoprobe groundwater samples during the fifth sampling round slightly above its surface water screening criteria. The Cooper River is a potential receptor based on groundwater flow and proximity. Therefore the pathway is considered valid, but given the concentrations and the potential for attenuation along the flowpath and dilution upon discharge, it is not expected to be significant.

Given the absence of surface soil exceedances for inhalation screening values, the soil to air pathway is considered invalid.

10.4.6 Human Health Risk Assessment

10.4.6.1 Site Background and Investigative Approach

The purpose of the investigation at AOC 678/679 (combined AOC 678) was the assessment of soil and groundwater potentially affected by past site activities. AOC 678 is the former firefighter school, former Building V-2, a potential site of controlled burning of ignitable materials. AOC 679 is a former wash rack location. There is no information regarding the type of structure that existed, operating practices or other activities conducted at these sites.

AOC 678 is the former site of Building 2-V, the Firefighter School, northeast of Building NS-1 in the northeastern portion of the southern peninsula. The firefighting school was reportedly constructed in 1947 and demolished circa 1955. Controlled fires may have been ignited and extinguished onsite for firefighter training. No other details regarding the design features or operating practices were available. Currently, the area is a paved parking lot.

AOC 679 consists of a former wash rack noted on early CNC maps for the 1930s and 1940s. This former wash rack was located off the west edge of Building NS-1. No information is available regarding the design features. Years of operation, or operating practices for the wash rack. It is assumed that activities at this unit included washing or cleaning of equipment in an external wash area.

The *Final Zone I RFI Work Plan* (E/A&H, February 1995) proposed three shallow monitoring wells at AOC 678/679. Subsequent to the work plan, geoprobe sample were collected to further define the extent of contamination at former firefighter "mock up" areas, and a fourth well was installed at the wash rack site. Six rounds of groundwater sampling were completed. During the first round of sampling, wells were sampled for VOCs, SVOCs, metals, cyanide, pesticides, PCBs, organotins, chlorides, TDS, and sulfates at DQO Level III. Samples from rounds two and three were analyzed for cyanide and metals. Fourth round samples were analyzed for chloride, cyanide, sulfate, metals, pesticides, VOCs, and TDS. Fifth round samples were taken from five shallow and four deep geoprobe samples collected along the boundary between AOC 679 and 680. These samples were analyzed for VOCs and SVOCs. A duplicate sample was taken in rounds two, three, four, and five. Sixth round sampling was conducted on well 679001 only and samples were analyzed for VOCs only. In addition, a shallow and deep grid-based monitoring well pair, GDI014 and GDI14D, was proposed and installed for use in characterizing the zone perimeter groundwater. Figure 10.4.1 shows the AOC 678/679 monitoring well and soil sampling locations.

10.4.6.2 COPC Identification

Soil

Based on the screening comparisons described in Section 7 of this RFI and presented in Table 10.4.11, the focus of this HHRA is on the following COPCs: benzo(a)pyrene equivalents, chromium, isodrin, and phorate. Wilcoxon rank sum test analyses did not result in the inclusion of any inorganic parameters that had been screened out on the basis of background concentration comparisons.

Groundwater

As shown in Table 10.4.12, no COPCs were identified in shallow groundwater for this site. Arsenic and manganese were detected at maximum concentrations exceeding their RBCs but not exceeding their background concentrations. These inorganic parameters were therefore eliminated from further consideration in the combined 678 HHRA. Wilcoxon rank sum test analyses did not result in the inclusion of any inorganic parameters that had been screened out on the basis of background concentration comparisons.

Table 10.4.11
Chemicals Present in Site Samples
AOC 678/679 - Surface Soil
Charleston Naval Complex
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration Residential RBC	Screening Concentration Background	Units	Number Exceeding RBC	Number Exceeding Background
Carcinogenic PAHs													
Benzo(a)pyrene Equivalents	*	4	21	37	253	110	850	970	87	NA	UG/KG	2	
Benzo(a)anthracene		3	21	27	180	88	660	750	870	NA	UG/KG		
Benzo(a)pyrene	*	4	21	29	200	86	660	750	87	NA	UG/KG	1	
Benzo(b)fluoranthene		4	21	31	240	133	760	860	870	NA	UG/KG		
Benzo(k)fluoranthene		4	21	21	170	100	620	700	8700	NA	UG/KG		
Chrysene		3	21	23	200	94	540	610	87000	NA	UG/KG		
Indeno(1,2,3-cd)pyrene		2	21	21	97	59	460	530	870	NA	UG/KG		
Inorganics													
Aluminum (Al)		23	23	3090	7580	5537	NA	NA	7800	27400	MG/KG		
Antimony (Sb)		4	23	0.21	0.39	0.303	0.2	4.5	3.1	ND	MG/KG		
Arsenic (As)		15	23	0.4	7.4	1.21	0.37	1.9	0.43	21.6	MG/KG	14	
Barium (Ba)		23	23	5.9	40.9	13.6	NA	NA	550	54.2	MG/KG		
Beryllium (Be)		12	23	0.03	0.41	0.118	0.03	0.18	16	0.95	MG/KG		
Cadmium (Cd)		5	23	0.12	0.5	0.278	0.03	0.06	7.8	0.61	MG/KG		
Calcium (Ca)	N	23	23	589	63100	12122	NA	NA	NA	NA	MG/KG		
Chromium (Cr)	*	23	23	6.5	116	25.6	NA	NA	39	34.5	MG/KG	3	5
Cobalt (Co)		21	23	0.64	10.7	1.53	0.58	0.64	470	5.8	MG/KG		1
Copper (Cu)		17	23	0.89	15.7	4.34	0.43	0.96	310	240	MG/KG		
Iron (Fe)	N	23	23	2060	4510	3233	NA	NA	NA	NA	MG/KG		
Lead (Pb)		23	23	3.9	31	8.72	NA	NA	400	203	MG/KG		
Magnesium (Mg)	N	23	23	202	3370	928	NA	NA	NA	NA	MG/KG		
Manganese (Mn)		22	23	7.5	81.4	34.2	26.6	28.7	160	419	MG/KG		
Mercury (Hg)		4	23	0.12	0.29	0.195	0.09	0.12	2.3	0.47	MG/KG		
Nickel (Ni)		23	23	1.9	9.3	3.41	NA	NA	160	23.9	MG/KG		
Potassium (K)	N	23	23	90.9	1240	248	NA	NA	NA	NA	MG/KG		
Selenium (Se)		6	23	0.49	0.82	0.612	0.15	0.5	39	1.49	MG/KG		
Sodium (Na)	N	11	23	95.6	302	229	86	190	NA	NA	MG/KG		
Tin (Sn)		17	23	0.97	2.2	1.33	0.84	100	4700	7.5	MG/KG		
Vanadium (V)		21	23	5.4	32.3	9.51	8.9	9.5	55	113	MG/KG		
Zinc (Zn)		23	23	4.2	87.6	17.4	NA	NA	2300	206	MG/KG		

Table 10.4.11
Chemicals Present in Site Samples
AOC 678/679 - Surface Soil
Charleston Naval Complex
Charleston, South Carolina

Parameter	Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration Residential RBC	Screening Concentration Background	Units	Number Exceeding RBC	Number Exceeding Background
Pesticides												
4,4'-DDD	7	21	9.5	170	62.1	3.8	4	2700	NA	UG/KG		
4,4'-DDE	11	21	4	480	67.4	3.8	4	1900	NA	UG/KG		
4,4'-DDT	5	21	4.3	86	28.9	3.8	4.1	1900	NA	UG/KG		
beta-BHC	2	21	1.4	2	1.7	1.1	11	350	NA	UG/KG		
Endrin	3	21	6.1	12	8.1	2.7	28	2300	NA	UG/KG		
Endrin aldehyde	5	21	1.1	1.3	1.2	1.1	11	2300	NA	UG/KG		
Methoxychlor	1	21	22	22	22	3.8	39	39000	NA	UG/KG		
Organophosphate Pesticides												
Methyl parathion	1	2	3.9	3.9	3.9	11	11	2000	NA	UG/KG		
Phorate *	1	2	10	10	10	11	11	1.6	NA	UG/KG	1	
Semivolatile Organics												
1-Methyl naphthalene	1	20	39	39	39	1100	1300	310000	NA	UG/KG		
2-Methylnaphthalene	1	21	110	110	110	380	970	310000	NA	UG/KG		
Acetophenone	1	20	240	240	240	660	760	780000	NA	UG/KG		
Anthracene	1	21	46	46	46	380	850	2300000	NA	UG/KG		
Benzo(g,h,i)perylene	1	21	110	110	110	620	710	310000	NA	UG/KG		
bis(2-Ethylhexyl)phthalate (BEHP)	2	21	55	240	148	740	870	46000	NA	UG/KG		
Di-n-butylphthalate	7	21	40	80	59.7	380	890	780000	NA	UG/KG		
Ethyl methacrylate	1	20	40	40	40	27	680	700000	NA	UG/KG		
Fluoranthene	4	21	26	330	121	910	1000	310000	NA	UG/KG		
Isodrin *	2	20	990	1000	995	910	1100	38	NA	UG/KG	2	
Methapyrilene **	1	20	50	50	50	1300	1500	NA	NA	UG/KG		
Naphthalene	2	21	60	68	64	380	760	310000	NA	UG/KG		
Phenanthrene	3	21	15	220	107	620	710	230000	NA	UG/KG		
Pyrene	4	21	33	330	128	730	830	230000	NA	UG/KG		
Volatile Organics												
Acetone	10	21	8	50	26.8	22	530	780000	NA	UG/KG		
Toluene	11	21	1	4	2.27	16	320	1600000	NA	UG/KG		
Trichlorotrifluoroethane (Freon 113)	1	20	4	4	4	11	12	230000000	NA	UG/KG		

Table 10.4.11
Chemicals Present in Site Samples
AOC 678/679 - Surface Soil
Charleston Naval Complex
Charleston, South Carolina

Parameter	Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration Residential RBC	Screening Concentration Background	Units	Number Exceeding RBC	Number Exceeding Background
TCDD Equivalents												
Dioxin (TCDD Equivalents)	2	2	0.0099	3.72	1.86	NA	NA	4.3	NA	NG/KG		

Notes:
* - Indicates chemical was identified as a COPC
** - No toxicity values were available for methapyrilene; therefore, risk could not be quantified. Methapyrilene will be discussed in Section 10.4.6.6 Risk Uncertainty.
N - Indicates chemical is an essential nutrient
SQL - Sample quantitation limit
RBC - Risk-based concentration
UG/KG - micrograms per kilogram
MG/KG - milligrams per kilogram
NG/KG - nanograms per kilogram
NA - Not applicable or not available
ND - Not determined due to lack of information

Table 10.4.12
Chemicals Present in Site Samples
AOC 678/679 - Groundwater
Charleston Naval Complex
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration Tap Water RBC	Background	Units	Number Exceeding RBC	Background
Inorganics													
Aluminum (Al)		5	9	26.2	204	100.4	25	103	3700	1440	UG/L		
Arsenic (As)		2	9	5.3	11.6	8.45	2.5	7.4	0.045	23	UG/L	2	
Barium (Ba)		5	9	10.1	21.8	15.1	5	22.5	260	110	UG/L		
Cadmium (Cd)		1	9	0.3	0.3	0.3	0.3	1.6	1.8	NA	UG/L		
Calcium (Ca)	N	9	9	78400	148000	107422	NA	NA	NA	NA	UG/L		
Chromium (Cr)		4	9	1.3	2.65	1.81	0.8	10.3	18	14.3	UG/L		
Iron (Fe)	N	8	9	355	4400	2084	20	20	NA	NA	UG/L		
Lead (Pb)		2	9	2.6	3.5	3.05	1.2	3	15	4.4	UG/L		
Magnesium (Mg)	N	9	9	14100	43250	31544	NA	NA	NA	NA	UG/L		
Manganese (Mn)		8	9	42.3	663.5	246.5	5	5	73	5430	UG/L	7	
Nickel (Ni)		3	9	1.5	2.5	1.97	0.8	5.7	73	13.3	UG/L		
Potassium (K)	N	9	9	4290	32700	20604	NA	NA	NA	NA	UG/L		
Selenium (Se)		1	8	3.1	3.1	3.1	2.8	5	18	ND	UG/L		
Sodium (Na)	N	7	9	10300	108500	76486	69800	106000	NA	NA	UG/L		
Vanadium (V)		1	9	1	1	1	0.5	3.4	26	14	UG/L		
Zinc (Zn)		1	9	11.5	11.5	11.5	4	15.8	1100	24.4	UG/L		
Volatile Organics													
Methylene chloride		1	5	1	1	1	5	10	4.1	NA	UG/L		

Notes:
* - Indicates chemical was identified as a COPC
N - Indicates chemical is an essential nutrient
SQL - Sample quantitation limit
RBC - Risk-based concentration
UG/L - micrograms per liter
NA - Not applicable or not available
ND - Not determined due to lack of information

10.4.6.3 Exposure Assessment

Exposure Setting

AOC 678 is a former firefighter school, former Building V-2, and potential site of controlled burning of ignitable materials. AOC 679 is a former wash rack. Surrounding land associated with combined AOC 678 is currently used as an asphalt-paved parking area. The future use of this combined AOC is unknown, although it is located in a section of CNC currently slated to become a marine cargo terminal in base reuse plans. All potable water is provided through the city's water supply. Shallow groundwater at the site is not currently nor anticipated to be used in the future as potable or process water.

Potentially Exposed Populations

Potentially exposed populations are current and future site workers, hypothetical future site residents and adolescent trespassers. Future site resident and worker exposure scenarios were addressed in this risk assessment. Current exposure to workers is discussed qualitatively in relation to the future workers and future residents. The hypothetical future site worker scenario assumed continuous exposure to surface soil conditions and the use of shallow groundwater as a potable water source. Current site workers' exposure would be less than that assumed for the hypothetical future site worker scenario because of their limited soil contact. Therefore, future worker assessment is considered to be protective of current site users. The resident child scenario was considered to be conservatively representative of the adolescent trespasser. The future site resident scenario was built on the premise that existing buildings would be removed and replaced with dwellings.

Exposure Pathways

Exposure pathways for the hypothetical future site residents and site workers are dermal contact with and incidental ingestion of COPCs in surface soils. The groundwater pathways were excluded because there were no COPCs identified. Uniform exposure was assumed for all sample locations. Table 10.4.13 presents the justification for exposure pathways assessed in this HHRA.

Exposure Point Concentrations

As discussed in Section 7 of this RFI, 95% UCLs were calculated for datasets consisting of at least 10 samples. 95% UCLs calculated for soils are presented in Table 10.4.14. Since less than 10 samples were collected for phorate, the maximum detected concentration was used as the EPC. As shown in Table 10.4.14, the maximum concentrations of benzo(a)pyrene equivalents were used to quantify exposure using the 'hot spot' approach. Benzo(a)pyrene equivalents were detected in only four of 23 surface soil samples collected (678SB001, 678SB003, 678SB008 and 679SB015), at a maximum concentration of 0.253 mg/kg. These samples were collected in the northwest section of the AOC and were surrounded by samples with no quantifiable concentrations of this COPC. As a result, it was deemed appropriate to derive a fraction ingested/contacted (FI/FC) factor accounting for the limited areal extent of the contaminant in surface soil. This factor was conservatively estimated to be 0.2, indicating that the maximum concentrations reported were representative of soil quality of 20% of the potential exposure area. The FI/FC factor was used to adjust the EPC for benzo(a)pyrene equivalents. The 95% UCLs were used as the EPCs for isodrin and chromium. Isodrin was detected in two samples (679SB006 and 679SB007) with a maximum concentration of 1,000 μg/kg. Based on the limited extent of the reported isodrin impacts, an FI/FC factor of 0.1 was conservatively estimated. This factor was used to adjust the EPC for isodrin.

Quantification of Exposure

Soil

CDIs for ingestion of and dermal contact with soils are shown in Tables 10.4.15 and 10.4.16, respectively.

Table 10.4.13
Exposure Pathways Summary — AOC 678/679
Charleston Naval Complex — Zone I
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Current Land Uses			
Current Site Users/Maintenance (Site Workers)	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	This exposure pathway was considered insignificant compared to the other pathways.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Shallow groundwater is not currently used as a source of potable or nonresidential water at combined AOC 678.
	Shallow groundwater, Inhalation of volatilized shallow groundwater contaminants	No	Shallow groundwater is not currently used as a source of potable or nonresidential water at combined AOC 678.
	Soil, Incidental ingestion	No (Qualified)	Future site use is considered conservatively representative of current site use.
	Soil, Dermal contact	No (Qualified)	Future site use is considered conservatively representative of current site use.
Future Land Uses			
Future Site Residents (Child and Adult) and Future Site Worker	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	This exposure pathway was considered insignificant compared to the other pathways.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	No COPCs were identified for shallow groundwater based on conservative screening.
	Shallow groundwater, Inhalation of volatilized contaminants during domestic use	No	No volatile COPCs were identified for shallow groundwater based on conservative screening.
	Soil, Incidental ingestion	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.
	Soil, Dermal contact	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.
	Wild game or domestic animals, Ingestion of tissue impacted by media contamination	No	Hunting/taking of game and/or raising livestock is prohibited within the Charleston, South Carolina city limits.
	Fruits and vegetables, Ingestion of plant tissues grown in media	No	The potential for significant exposure via this pathway is low relative to that of other exposure pathways assessed.

Table 10.4.14
Statistical Analysis of COPCs
Surface Soils at AOC 678/679
Charleston Naval Complex
Charleston, South Carolina

COPC	Natural Log Transformed n	mean	SD	H-stat	UCL (mg/kg)	MAX (mg/kg)	EPC (mg/kg)	
Benzo(a)pyrene Equivalents	21	-0.480577	0.315729	1.844	0.740	0.253	0.253	MAX
Chromium (Cr)	23	2.980767	0.708882	2.183	35.2	116	35.2	UCL
Isodrin	20	-0.623983	0.209031	1.783	0.597	1.00	0.597	UCL
Phorate	2	NA	NA	NA	NA	0.01	0.01	MAX

NOTES:

mean arithmetic mean of the logtransformed data
n number of samples analyzed
SD standard deviation for a sample of data
H-stat "H" statistic from Gilbert 1987; cuboidal interpolation was used to determine the value in accordance with USEPA Supplemental Guidance to RAGS, Calculating the Concentration Term
NA not applicable
EPC exposure point concentration
UCL 95 percentile upper confidence level mean
MAX maximum reported concentration

Table 10.4.15
Chronic Daily Intakes (CDI)
Incidental Ingestion of Surface Soil
AOC 678/679
Charleston Naval Complex
Charleston, SC

Chemical	Fraction Ingested from Contaminated Source	Exposure Point Concentration (mg/kg)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident LWA C-CDI (mg/kg-day)	Future Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Benzo(a)pyrene Equivalent	0.2	0.253	6.93E-08	6.47E-07	7.92E-08	2.47E-08	8.84E-09
Chromium (Cr)	1	35.2	4.83E-05	4.50E-04	5.52E-05	1.72E-05	6.16E-06
Isodrin	0.1	0.597	8.17E-08	7.63E-07	9.34E-08	2.92E-08	1.04E-08
Phorate	1	0.01	1.37E-08	1.28E-07	1.57E-08	4.89E-09	1.75E-09

NOTES:

LWA	lifetime weighted average; used to calculate carcinogenic CDI, RAGS Parts A and B
CDI	Chronic Daily Intake in mg/kg-day
H-CDI	CDI for hazard quotient
C-CDI	CDI for excess cancer risk

Table 10.4.16
Chronic Daily Intakes (CDI)
Dermal Contact with Surface Soil
AOC 678/679
Charleston Naval Complex
Charleston, SC

Chemical	Exposure Point Concentration (mg/kg)	Fraction Contacted from Contaminated Source *	Dermal Absorption Factor+ (unitless)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident LWA C-CDI (mg/kg-day)	Future Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Benzo(a)pyrene Equivalents	0.253	0.2	0.01	2.84E-08	9.38E-08	1.78E-08	2.03E-08	7.25E-09
Chromium (Cr)	35.2	1	0.001	1.98E-06	6.53E-06	1.24E-06	1.41E-06	5.05E-07
Isodrin	0.597	0.1	0.01	3.35E-08	1.11E-07	2.10E-08	2.39E-08	8.55E-09
Phorate	0.01	1	0.01	5.62E-09	1.85E-08	3.52E-09	4.01E-09	1.43E-09

NOTES:

CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
+ The dermal absorption factor was applied to the exposure point concentration to reflect the different trans-dermal migration of inorganic versus organic chemicals
* Reflects the estimated fraction of the site impacted by the corresponding COPC.

10.4.6.4 Toxicity Assessment

Toxicity assessment terms and methods are discussed in Section 7 of this report. Table 10.4.17 presents toxicological information specific to each COPC identified at combined AOC 678. This information was used in the quantification of risk potentially associated with soil and groundwater contaminants. Brief toxicological profiles for each COPC are provided in the following paragraphs.

Benzo(a)pyrene equivalents include the following list of polynuclear aromatic hydrocarbons (PAHs):

Benzo(a)anthracene	TEF 0.1
Benzo(b)fluoranthene	TEF 0.1
Dibenz(a,h)anthracene	TEF 1.0
Benzo(k)fluoranthene	TEF 0.01
Benzo(a)pyrene	TEF 1.0
Indeno(1,2,3-cd)pyrene	TEF 0.1
Chrysene	TEF 0.001

Some PAHs are toxic to the liver, kidney, and blood. However, the toxic effects of the PAHs above have not been well established. There are no RfDs for the PAHs above due to a lack of data. All PAHs listed above are classified by USEPA as B2 carcinogens, and their carcinogenicity is addressed relative to that of benzo(a)pyrene, having an oral SF of 7.3 $(mg/kg\text{-}day)^{-1}$. Toxicity Equivalency Factors (TEFs), also set by USEPA, are multipliers that are applied to the detected concentrations, which are subsequently used to calculate excess cancer risk. Most carcinogenic PAHs have been classified as such due to animal studies using large doses of purified PAHs. There is some doubt as to the validity of these listings, and the SFs listed in USEPA's RBC table are provisional. However, these PAHs are carcinogens when the exposure involves a mixture of

Table 10.4.17

Toxicological Reference Information

for Chemicals of Potential Concern

AOC 678/679

Charleston Naval Complex

Charleston, South Carolina

	Non-Carcinogenic Toxicity Data								*Carcinogenic Toxicity Data*			
Chemical	**Oral Reference Dose (mg/kg-day)**	**Confidence Level**	**Critical Effect**	**Uncertainty Factor Oral**	**Inhalation Reference Dose (mg/kg-day)**	**Confidence Level**	**Critical Effect**	**Uncertainty Factor Inhalation**	**Oral Slope Factor (kg-day/mg)**	**Inhalation Slope Factor (kg-day/mg)**	**Weight of Evidence**	**Tumor Type**
BEQ	NA	NA	NA	NA	NA	NA	NA	NA	7.3 a	3.1 c	B2	mutagen
Chromium III	1 a	L	NA	100/10	NA	NA	NA	NA	NA	NA a	D	NA
Chromium VI	0.005 a	L	NA	500	1E-07 c	NA	NA	NA	NA	41 a	A	lung
Isodrin	0.00003 a	M	liver toxicity	1000	NA	NA	NA	NA	17 a	17 a	B2	carcinoma
Phorate	0.0002 b	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

a = Integrated Risk Information System (IRIS)

b = Health Effects Assessment Summary Tables (HEAST)

c = EPA NCEA - Cincinnati (provisional)

NA = Not applicable or not available

H = High confidence

L = Low confidence

M = Medium confidence

other carcinogenic substances (e.g., coal tar, soot, cigarette smoke, etc.). As listed in IRIS, the basis for the benzo(a)pyrene B2 classification is animal data. Human data specifically linking benzo(a)pyrene to a carcinogenic effect are lacking. There are, however, multiple animal studies in many species demonstrating benzo(a)pyrene to be carcinogenic by numerous routes.

Chromium exists in two stable, natural forms: trivalent (CrIII) and hexavalent (CrVI). Acute exposure to chromium can result in kidney damage following oral exposure or damage to the nasal mucosa and septum following inhalation exposure. Chronic inhalation exposure to hexavalent chromium has resulted in kidney and respiratory tract damage, as well as excess lung cancer in both animals and humans following occupational exposure. Only hexavalent chromium is believed to be carcinogenic by inhalation (IRIS, 1999). Oral RfD values are 1.0 mg/kg-day (trivalent chromium) and 5E-3 mg/kg-day (hexavant chromium). For trivalent chromium, the RfD is based on liver toxicity in the rat. For the hexavalent form, the RfD is based on unspecified pathological changes observed in rat studies. In addition, hexavalent chromium is considered a group A carcinogen for inhalation exposures, and a inhalation SF of 41 $(mg/kg\text{-}day)^{-1}$ has been established for the hexavalent form. Vitamin supplements contain approximately 0.025 mg of chromium. As listed in IRIS, no critical effects were observed for chromium (III). The uncertainty factor was 100 and the modifying factor was 10. As listed in IRIS, no critical effects were observed for chromium (VI). The uncertainty factor was 500 and the modifying factor was 1.

Isodrin is structurally related to Aldrin (i.e., a stereo isomer) and endrin (the epoxide form of isodrin). Toxicity criteria specific to isodrin were unavailable in IRIS or HEAST. For purposes of this HHRA, toxicity criteria for Aldrin were adopted to estimate risk associated with isodrin. Although endrin has not been classified as a carcinogen by USEPA, aldrin is a B2 carcinogen. Therefore, using aldrin as a surrogate compound is more conservative than using endrin as a surrogate. Aldrin, a chlorinated pesticide, is metabolized into its epoxide form — dieldrin. Short-term exposure to high doses of aldrin and dieldrin causes tremors and convulsions. Chronic exposure can cause emotional and neuromuscular disturbances, and reproductive effects have also been shown to be caused by overexposure to these pesticides. Aldrin accumulates in adipose tissue as an epoxide (i.e., in the form of dieldrin) (Klaassen, et al., 1986). Exposed individuals revert to normal approximately one week after the dieldrin source is removed (Dreisbach, et al, 1987).

Phorate is an organophosphorus insecticide and acaricide used to control sucking and chewing insects and is used in pine forests and on root and field crops. The critical effect for phorate is chloinesterase inhibition. Phorate is readily absorbed by the skin and the gastrointestinal tract. The major breakdown products of phorate in mammals are more toxic and have greater anticholinesterase activity than phorate (EXTOXNET). HEAST lists a chronic oral RfD of 0.0002 mg/kg-day.

10.4.6.5 Risk Characterization

Surface Soil Pathways

Exposure to surface soil onsite was evaluated under both residential and industrial (site worker) scenarios. For these scenarios, the incidental ingestion and dermal contact exposure pathways were evaluated. For noncarcinogenic contaminants evaluated for future site residents, HQs were computed separately to address child and adult exposure. Tables 10.4.18 and 10.4.19 present the computed carcinogenic risks and/or HQs associated with the incidental ingestion of and dermal contact with COPs in site surface soils, respectively.

Hypothetical Site Residents

The ingestion ILCR (based on the adult and child lifetime weighted average) for combined AOC 678/679 surface soils is 2E-06. The dermal pathway ILCR is 1E-06. Isodrin was the primary contributor for each pathway with benzo(a)pyrene equivalents contributing to a lesser extent.

Table 10.4.18
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
AOC 678/679
Charleston Naval Complex
Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used $(mg/kg\text{-}day)^{-1}$	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident LWA ILCR	Future Worker adult Hazard Quotient	Future Worker adult ILCR
Benzo(a)pyrene Equivalent	NA	7.3	ND	ND	5.8E-07	ND	6.5E-08
Chromium (Cr)	0.005	NA	0.010	0.090	ND	0.0034	ND
Isodrin *	0.00003	17	0.0027	0.025	1.6E-06	0.0010	1.8E-07
Phorate	0.0002	NA	0.000068	0.00064	ND	0.000024	ND
SUM Hazard Index/ILCR			0.01	0.1	2E-06	0.004	2E-07

NOTES:
* The RfDo and SFo for aldrin were used as surrogate toxicity values for isodrin.
NA Not available
ND Not Determined due to lack of available information
LWA lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

Table 10.4.19
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
AOC 678/679
Charleston Naval Complex
Charleston, SC

Chemical	Dermal Adjustment+	Oral RfD Used (mg/kg-day)	Oral SF Used $(mg/kg\text{-}day)^{-1}$	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident LWA ILCR	Future Worker adult Hazard Quotient	Future Worker adult ILCR
Benzo(a)pyrene Equivalents	0.5	ND	14.6	ND	ND	2.6E-07	ND	1.1E-07
Chromium (Cr)	0.2	0.001	ND	0.0020	0.0065	ND	0.0014	ND
Isodrin *	0.5	0.000015	34	0.0022	0.0074	7.1E-07	0.0016	2.9E-07
Phorate	0.5	0.0001	ND	0.000056	0.00019	ND	0.000040	ND
SUM Hazard Index/ILCR				0.004	0.01	1E-06	0.003	4E-07

NOTES:

NA Not available
ND Not Determined due to lack of available information
LWA lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk
+ Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)
* The RfD and SG for aldrin were used as surrogate toxicity values for isodrin.

The computed hazard indices for the adult resident were 0.01 for the soil ingestion pathway and 0.004 for the dermal contact pathway. The computed hazard indices for the child ingestion and dermal contact pathways were 0.1 and 0.01 respectively. The primary contributors were chromium and isodrin in each case.

Future Site Workers

Site worker ILCRs are 2E-07 and 4E-07 for the ingestion and dermal contact pathways, respectively. Each COPC contributed less than 1E-06 to the sum ILCR for both pathways. Hazard indices for the ingestion and dermal hypothetical pathways were both projected to be less than 0.01 for the future site worker scenario.

The entire area which comprises combined AOC 678/679 is an asphalt parking lot. Current site users have little chance of exposure to affected surface soil. As a result, the risk/hazard projections discussed above are considered gross overestimates should existing site features be maintained under future use scenarios.

COCs Identified

COCs were identified based on cumulative (all pathway) risk projected for this site, as shown in Table 10.4.20. USEPA has established a generally acceptable risk range of 1E-04 to 1E-06, and a hazard index threshold of 1 (unity). As recommended by SCDHEC, a COC was considered to be any chemical contributing to a cumulative risk level of 1E-06 or greater and/or a cumulative hazard index above 1, and whose individual ILCR exceeds 1E-06 or whose HQ exceeds 0.1. For carcinogens, this approach is relatively conservative, because a cumulative risk level of 1E-04 (and individual ILCR of 1E-06) is recommended by USEPA Region IV as the trigger for establishing COCs. The COC selection method presented was used in order to provide a more comprehensive evaluation of chemicals contributing to carcinogenic risk or noncarcinogenic hazard during the remedial goal options development process.

Table 10.4.20
Summary of Risk and Hazard-based COCs for AOC 678/679
Charleston Naval Complex
Charleston, South Carolina

Medium	Exposure Pathway		Future Resident Adult Hazard Quotient	Future Resident Child Hazard Quotien	Future Resident LWA ILCR	Site Hazard Quotient	Worker ILCR	Identification of COCs
Surface Soil	Incidental Ingestion	Benzo(a)pyrene Equivalents	ND	ND	5.8E-07	ND	6.5E-08	
		Chromium (Cr)	0.010	0.090	ND	0.0034	ND	
		Isodrin	0.0027	0.025	1.6E-06	0.0010	1.8E-07	2
		Phorate	0.000068	0.00064	ND	0.000024	ND	
	Dermal Contact	Benzo(a)pyrene Equivalents	ND	ND	2.6E-07	ND	1.1E-07	
		Chromium (Cr)	0.0020	0.0065	ND	0.0014	ND	
		Isodrin	0.0022	0.0074	7.1E-07	0.0016	2.9E-07	
		Phorate	0.000056	0.00019	ND	0.000040	ND	
Surface Soil Pathway Sum			0.017	0.13	3E-06	0.007	6E-07	
Sum of All Pathways			0.017	0.13	3E-06	0.007	6E-07	

Notes:
ND indicates not determined due to the lack of available risk information.
ILCR indicates incremental excess lifetime cancer risk
HI indicates hazard index
1- Chemical is a COC by virtue of projected child residence non-carcinogenic hazard.
2- Chemical is a COC by virtue of projected future resident lifetime ILCR.
3- Chemical is a COC by virtue of projected site worker non-carcinogenic hazard.
4- Chemical is a COC by virtue of projected site worker ILCR.

Surface Soils

Hypothetical Site Residents

Isodrin was identified as the sole soil pathway COC based on its contribution to cumulative ILCR projections.

Future Site Workers

No COCs were identified for this scenario based on the sum ILCR and hazard index.

The extent of the COCs identified in surface soil is briefly discussed below. To facilitate this discussion of the extent of COC concentrations, residential soil RBCs were compared to each reported concentration for each COC identified above. RBCs used for this comparison were based on an ILCR of 1E-06 and/or a HQ of 1 (where applicable). Isodrin was the sole COC identified for surface soil, and was detected in two samples (679SB006 and 679SB007) with a maximum concentration of 1,000 μg/kg. Based on the limited extent of the reported isodrin impacts, an FI/FC factor of 0.1 was conservatively estimated. This factor was used to adjust the EPC for isodrin.

10.4.6.6 Risk Uncertainty

Characterization of Exposure Setting and Identification of Exposure Pathways

The potential for high bias is introduced through the exposure setting and pathway selection due to the highly conservative assumptions (i.e., future residential use) recommended by USEPA Region IV when assessing potential future and current exposure. The exposure assumptions made in the site worker scenario are highly protective and would tend to overestimate exposure. The entire area is covered by an asphalt surface, thus precluding exposure to affected surface soil. Current site workers are not exposed to site groundwater.

Residential use of the site would not be expected, based on current site uses and the nature of surrounding buildings. Current reuse plans call for continued commercial/industrial use of Zone I, specifically as a marine cargo terminal. If this area were to be used as a residential site, the buildings would be demolished, asphalt surface removed, and the surface soil conditions would likely change — the soils could be covered with landscaping soil and/or a house. Consequently, exposure to conditions as represented by samples collected during the RFI would not be likely under a true future residential scenario. These factors indicate that exposure pathways assessed in this HHRA would generally overestimate the risk and hazard posed to current site workers and future site residents.

Shallow groundwater is not currently used at combined AOC 678/679 for potable or industrial purposes. A basewide system provides drinking and process water to buildings throughout Zone I. This system is slated to remain in operation under the current base reuse plan. As a result, shallow groundwater would not be expected to be used under future site use scenarios. Therefore, the scenario evaluated in this HHRA is highly conservative, and associated pathways are not expected to be completed in the future.

Determination of Exposure Point Concentrations

Since less than 10 samples were collected for phorate, the maximum detected concentration was used as the EPC. The maximum concentrations of benzo(a)pyrene equivalents were used to quantify exposure using the 'hot spot' approach. The 95% UCLs of the reported soil concentrations were used as the exposure point concentrations for chromium and isodrin at this site.

Frequency of Detection and Spatial Distribution

Isodrin was the sole COC identified for surface soil. It was detected in two samples (679SB006 and 679SB007), with a maximum concentration of 1,000 μg/kg. The fraction ingested from contaminated source (based on the spatial distribution and frequency of detection for each COPC) was considered in the exposure calculations at combined AOC 678/679. Based on the limited extent of the reported isodrin impacts, an FI/FC factor of 0.1 was conservatively estimated. This factor was used to adjust the EPC for isodrin. Further sampling in the vicinity of reportedly impacted surface soil locations could serve to reduce further the FI/FC factor, and thus consequent exposure estimates.

Quantification of Risk/Hazard

As indicated by the discussions above, the uncertainty inherent in the risk assessment process is great. In addition, many site-specific factors have affected the uncertainty of this assessment that would upwardly bias the risk and hazard estimates. Exposure pathway-specific sources of uncertainty are discussed below.

Soil

Of the CPSSs screened and eliminated from formal assessment, none was reported at a concentration close to its corresponding RBC (i.e., within approximately 10% of the RBC). This minimizes the likelihood of potentially significant cumulative risk/hazard based on the eliminated CPSSs. Concentrations of arsenic exceeded its corresponding RBC, but did not exceed its corresponding background reference concentration. Therefore, it was eliminated from formal assessment based on comparisons to background concentrations. Isodrin, the only soil COC, would not be expected to be associated with past hazardous waste activities at the site. No toxicity values were available for methapyrilene; therefore risk could not be quantified.

Central tendency (CT) analysis was not formally performed for combined AOC 678/679 surface soil, but a simplified approach was taken to assess the potential influences of CT assumptions. The comparison of RME as well as CT results is consistent with the risk characterization policy implemented by USEPA. The CT assumption for residential exposure duration is 9 years compared to the 30 year assumption for RME. The CT exposure frequency assumption is 234 days/year compared to 350 days/year RME. If all other exposure assumptions remain fixed, application of the CT exposure duration and frequency would result in risk projections 80% below the RME. At CT, the residential surface soil pathway related risk (incidental ingestion and dermal contact) would fall below the 1E-06 point of departure.

Current base reuse plans call for conversion of the area to a marine cargo terminal. Both the future worker and residential exposure scenarios were assessed in this HHRA. As previously discussed, it is likely that these scenarios would lead to overestimates of risk and/or hazard.

Groundwater

The same conservative screening process used for soil was also used for groundwater. Concentrations of arsenic and manganese exceeded their corresponding RBCs, but did not exceed their corresponding background reference concentrations. Therefore, they were eliminated from formal assessment based on comparisons to background reference concentrations.

Background-Related Risk

Soil

Arsenic was detected in combined AOC 678/679 surface soil above its respective RBC. This element was not considered in the risk assessment based on comparison to background concentrations. It is not unusual for naturally occurring or background concentrations of some elements to exceed risk-based concentrations. It is the risk assessment's function to identify excess risk or that which is above background levels. The following is a discussion of the residential scenario risk/hazard associated with background concentrations of arsenic.

The maximum surface soil concentration of arsenic (7.4 mg/kg) equates with ILCRs of 2E-05 and 3E-06 for the residential and site worker scenarios, respectively. The maximum reported concentration of arsenic equates with HQs of 0.34 and 0.02 for the residential child and site worker, respectively. The background value for arsenic (21.6 mg/kg) equates with ILCRs of 5.6E-05 and 8E-06, and HQs of 0.99 and 0.05 for the residential and site worker scenarios, respectively.

Groundwater

Arsenic and manganese were detected in combined AOC 678/679 groundwater above their respective tap water RBCs. These elements were not considered in the risk assessment based on comparison to background concentrations. The following is a discussion of the residential scenario risk/hazard associated with background concentrations of arsenic and manganese.

The background shallow groundwater concentration for arsenic (23 μg/L) which is below the MCL, equates with an ILCR of 5E-04 (based on the adult and child lifetime weighted average) and 2E-04 for the site worker and HQs of 5 and 1.5 for the residential child and site worker, respectively. The maximum reported concentration of arsenic (11.6 μg/L) equates with an ILCR of 3E-04 based on child and an ILCR of 1E-04 for the site worker. The maximum reported concentration of arsenic also equates with HQs of 2.5 and 0.8 for the residential child and site worker, respectively. The background shallow groundwater concentration of manganese (5,430 μg/L) equates with HQs of 6 and 5 for the resident child and site worker, respectively. The maximum reported concentration of manganese (664 μg/L) yielded HQs of 0.8 and 0.6 for the residential and site worker scenarios, respectively. There were no COPCs identified for combined AOC 678/679 shallow groundwater.

10.4.6.7 Risk Summary

The risk and hazard posed by contaminants at combined AOC 678/679 were assessed for the hypothetical future site worker and the hypothetical future site resident under reasonable maximum exposure assumptions. In surface soils, the incidental ingestion and dermal contact pathways were assessed in this HHRA. The groundwater pathway was not assessed since there were no COPCs identified. Table 10.4.21 presents the risk summary for each pathway/receptor group evaluated for combined AOC 678/679.

Soil — Residential Scenario

The residential soil pathway COC identified for combined AOC 678/679 is isodrin. Figures 10.4.9 and 10.4.10 illustrate point risk and hazard estimates for combined AOC 678/679 based on surface soil exposure pathways under a future residential scenario. Table 10.4.22 summarizes the risk and hazard contribution of each COPC at each sample location. This point risk map is based on the unlikely assumption that a potential future site resident will be chronically exposed to specific points. Exposure to surface soil conditions is more likely the result of uniform exposure to the soil conditions of the entire site (or exposure unit area) rather than specific points. With this in mind, risk maps supplemented by the tables are useful in that they allow the reader to visualize how chemicals driving risk estimates are spatially distributed across the site.

Only two sample locations yielded ILCRs that were greater than 1E-06 (678SB003 and 678SB008). Benzo(a)pyrene equivalents were the primary contributors to risk at these locations. Risk estimates at combined AOC 678 ranged from 6E-07 at 679SB015 to 4E-06 at 678SB003 with a mean risk estimate of 4E-07.

Soil — Future Site Worker Scenario

No industrial soil pathway COCs were identified for combined AOC 678/679.

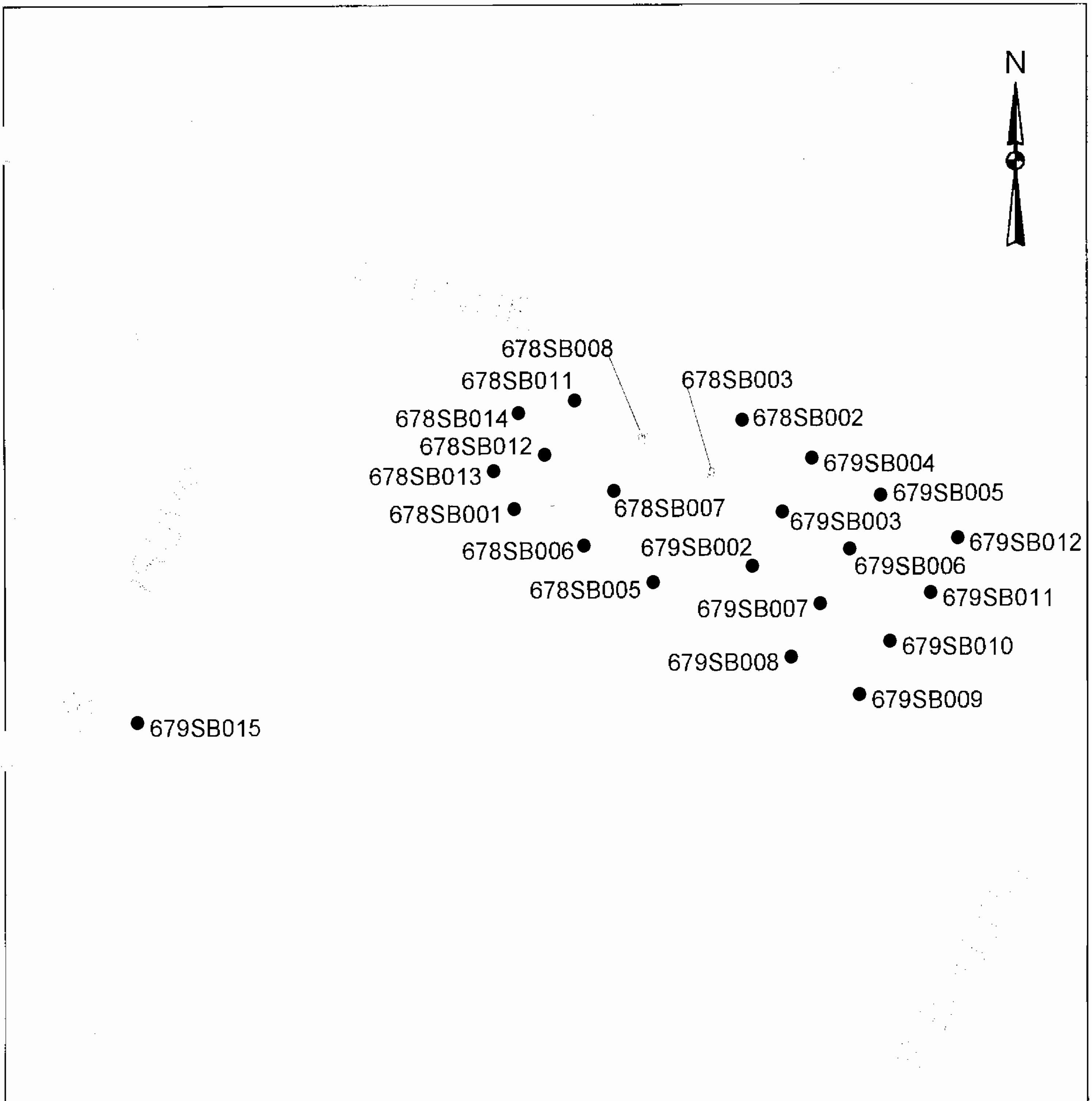
Groundwater — Residential Scenario

There were no COPCs identified for combined AOC 678/679 groundwater.

Table 10.4.21
Summary of Risk and Hazard for AOC 678/679
Charleston Naval Complex
Charleston, South Carolina

Medium	Exposure Pathway	HI (Adult)	HI (Child)	ILCR (LWA)	HI (Worker)	ILCR (Worker)
Surface Soil	Incidental Ingestion	0.01	0.1	2E-06	0.004	2E-07
	Dermal Contact	0.004	0.01	1E-06	0.003	4E-07
Sum of All Pathways		0.017	0.13	3E-06	0.007	6E-07

Notes:
ND indicates not determined due to the lack of available risk information.
ILCR indicates incremental excess lifetime cancer risk
HI indicates hazard index



LEGEND

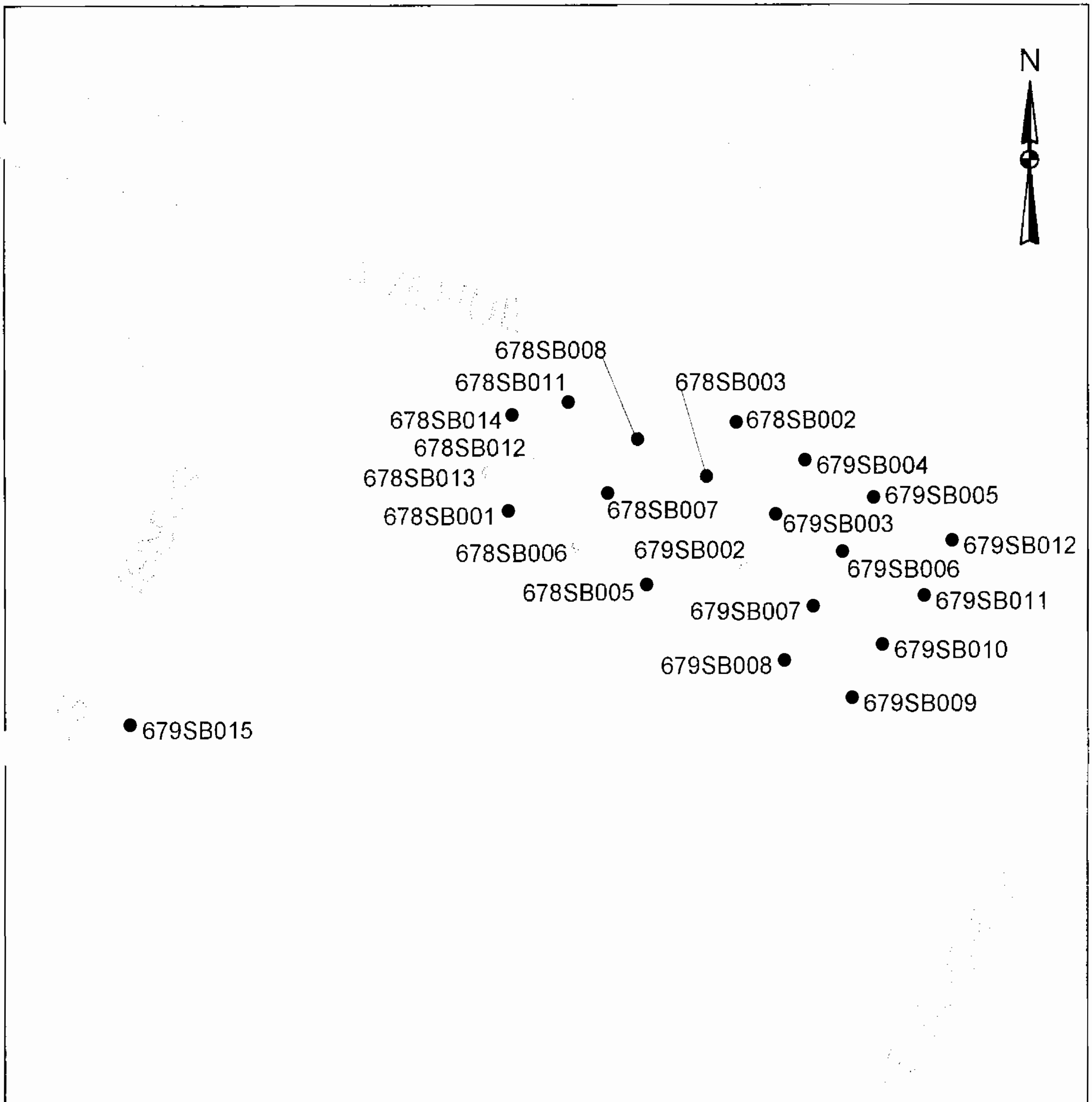
- NO COPCs
- < 1E-6
- 1E-6 to 5E-6
- 5E-6 to 1E-5
- 1E-5 to 1E-4
- > 1E-4

80 0 80 160 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.4.9
ZONE I
AOCs 678 and 679

SURFACE SOIL POINT RISK
RESIDENTIAL SCENARIO



LEGEND

- NO COPCs
- 0 to 0.1
- 0.1 to 0.5
- 0.5 to 1.0
- 1.0 to 3.0
- > 3.0

80 0 80 160 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.4.10
ZONE I
AOCs 678 and 679

SURFACE SOIL HAZARD INDEX
RESIDENTIAL SCENARIO

Table 10.4.22
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
AOC 678/679
Charleston Naval Complex
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	Risk (E-06)
678	B001	BEQs	56.10	UG/KG	NA	0.93
678	B001	Chromium (Cr)	27.70	MG/KG	0.0760	NA
				Total	0.0760	0.93
678	B002	Chromium (Cr)	6.50	MG/KG	0.0178	NA
678	B003	BEQs	252.90	UG/KG	NA	4.19
678	B003	Chromium (Cr)	28.00	MG/KG	0.0768	NA
				Total	0.0768	4.19
678	B005	Chromium (Cr)	29.50	MG/KG	0.0809	NA
678	B006	Chromium (Cr)	116.00	MG/KG	0.3181	NA
678	B007	Chromium (Cr)	11.90	MG/KG	0.0326	NA
678	B008	BEQs	92.36	UG/KG	NA	1.53
678	B008	Chromium (Cr)	35.80	MG/KG	0.0982	NA
				Total	0.0982	1.53
678	B011	Chromium (Cr)	10.70	MG/KG	0.0293	NA
678	B012	Chromium (Cr)	36.60	MG/KG	0.1004	NA
678	B013	Chromium (Cr)	41.70	MG/KG	0.1144	NA
678	B014	Chromium (Cr)	34.50	MG/KG	0.0946	NA
679	B002	Chromium (Cr)	44.75	MG/KG	0.1227	NA
679	B003	Chromium (Cr)	7.70	MG/KG	0.0211	NA
679	B004	Chromium (Cr)	8.50	MG/KG	0.0233	NA
679	B005	Chromium (Cr)	12.10	MG/KG	0.0332	NA
679	B006	Chromium (Cr)	13.90	MG/KG	0.0381	NA
679	B006	Isodrin	990.00	UG/KG	NA	NA
				Total	0.0381	NA
679	B007	Chromium (Cr)	15.20	MG/KG	0.0417	NA
679	B007	Isodrin	1,000.00	UG/KG	NA	NA
				Total	0.0417	NA
679	B008	Chromium (Cr)	21.80	MG/KG	0.0598	NA
679	B009	Chromium (Cr)	8.70	MG/KG	0.0239	NA
679	B010	Chromium (Cr)	10.50	MG/KG	0.0288	NA
679	B011	Chromium (Cr)	32.05	MG/KG	0.0879	NA
679	B011	Phorate	10.00	UG/KG	0.0008	NA
				Total	0.0887	NA
679	B012	Chromium (Cr)	16.60	MG/KG	0.0455	NA
679	B015	BEQs	37.13	UG/KG	NA	0.61
679	B015	Chromium (Cr)	18.10	MG/KG	0.0496	NA
				Total	0.0496	0.61

10.4.6.8 Remedial Goal Options

Soil

RGOs for carcinogens were based on the lifetime weighted average site resident as presented in Table 10.4.23 for surface soils. Hazard-based RGOs were calculated based on the hypothetical child resident, as noted in the corresponding table. No site worker RGOs were calculated as no surface soil COCs were identified for this receptor group.

10.4.7 Corrective Measures Considerations

Based on the analytical results and the human health risk assessment for AOC 678\679, COCs requiring further evaluation through the CMS process have been identified for surface soil. No COCs were identified for site groundwater. The site is currently in a moderately developed urban setting and risk to human health was evaluated under both the future residential and future industrial (site worker) scenarios. For these scenarios, the incidental ingestion and dermal contact exposure pathways were evaluated. Hazard was evaluated for noncarcinogenic contaminants through incidental ingestion and dermal contact scenarios as well.

As recommended by SCDHEC, a COC is considered to be any chemical contributing to a cumulative risk level of 1E-06 or greater and/or a cumulative hazard index above 1.0, and whose individual risk exceeds 1E-06 or whose hazard quotient exceeds 0.1.

Isodrin was identified as the only soil pathway COC for AOC 678/679. Table 10.4.24 presents cumulative and COC-specific exposure risks and hazard quotients.

Risk-based remedial goals for surface soil are presented in Table 10.4.23. Potential corrective measures for soil are presented in Table 10.4.25.

Table 10.4.23
Residential-Based Remedial Goal Options Surface Soil
AOC 678/679
Charleston Naval Complex
Charleston, South Carolina

Chemical	Slope Factor (mg/kg-day)$^{-1}$	Reference Dose (mg/kg-day)	EPC mg/kg	Hazard-Based Remedial Goal Options **3** mg/kg	**1** mg/kg	**0.1** mg/kg	Risk-Based Remedial Goal Options **1E-06** mg/kg	**1E-05** mg/kg	**1E-04** mg/kg	Background Concentration mg/kg
Isodrin	17	0.00003	0.597	55	18	1.8	0.26	2.6	26	ND

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined
\- remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident for noncarcinogens

Table 10.4.24
AOC 678/679
Cumulative and Chemical-Specific Exposure Risks and Hazard

	Risk		Hazard	
Chemical	**Industrial**	**Residential**	**Industrial**	**Residential**
Soil				
Isodrin	3.6E-7	2.3E-6	0.0026	0.0324
Cumulative	3.6E-7	2.3E-6	0.0026	0.0324

Note:
ND = Not detected

Table 10.4.25
AOC 678/679
Potential Corrective Measures

Medium	Compounds	Potential Corrective Measures
Soil	Isodrin	a) No action b) Excavate, offsite disposal, and monitoring c) Containment/capping

10.5 AOC 680, Building NS-26 UST and Grinding Room/Brake Repair Area

AOC 680 includes Building NS-26 and associated former grinding room/brake repair area. Building NS-26 was part of the Navy's Shore Intermediate Activity (SIMA) complex. The building was constructed in 1958 and renovated in 1985. Structures associated with NS-26 include several storage sheds and steel storage trailers.

Three dip tanks were located in the west end of the facility and were used to clean ship parts. The contents of the tanks were tri-sodium phosphate, citric acid, and water. The tanks reportedly were cleaned bi-annually by CNC personnel.

An initial assessment study in 1981 noted that the following hazardous wastes were generated at this facility: boiler cleaning solution (sulfuric acid and nitric acid); cleaning solvents (chlorinated hydrocarbons); and boiler test chemicals (mercuric nitrate). From 1958 through 1981, disposal practices reportedly included discharging neutralized boiler solutions, solvents, and mercuric nitrate solutions directly into the Cooper River.

Historic information indicates that the area was used as a seaplane refueling ramp and as an oil storage area in the 1940s.

In December 1996, a 200 gallon waste oil UST located on the north side of NS-26 was closed by removal. The UST assessment report noted that the tank and associated piping was severly corroded and pitted but no holes were found. The assessment report also notes that the oil-water separator associated with this UST and referenced on early building plans could not be located at the time of UST removal. It is assumed that the oil-water separator has not been used since the building renovations in 1985. The waste oil tank apparently continued to be used after 1985 by pouring used oil down the pump-out piping.

Materials of concern include VOCs and SVOCs. Potential receptors, include future site workers who may be involved in invasive activity that might bring them in direct contact with subsurface contaminants. The ecology of the Cooper River is also a potential receptor.

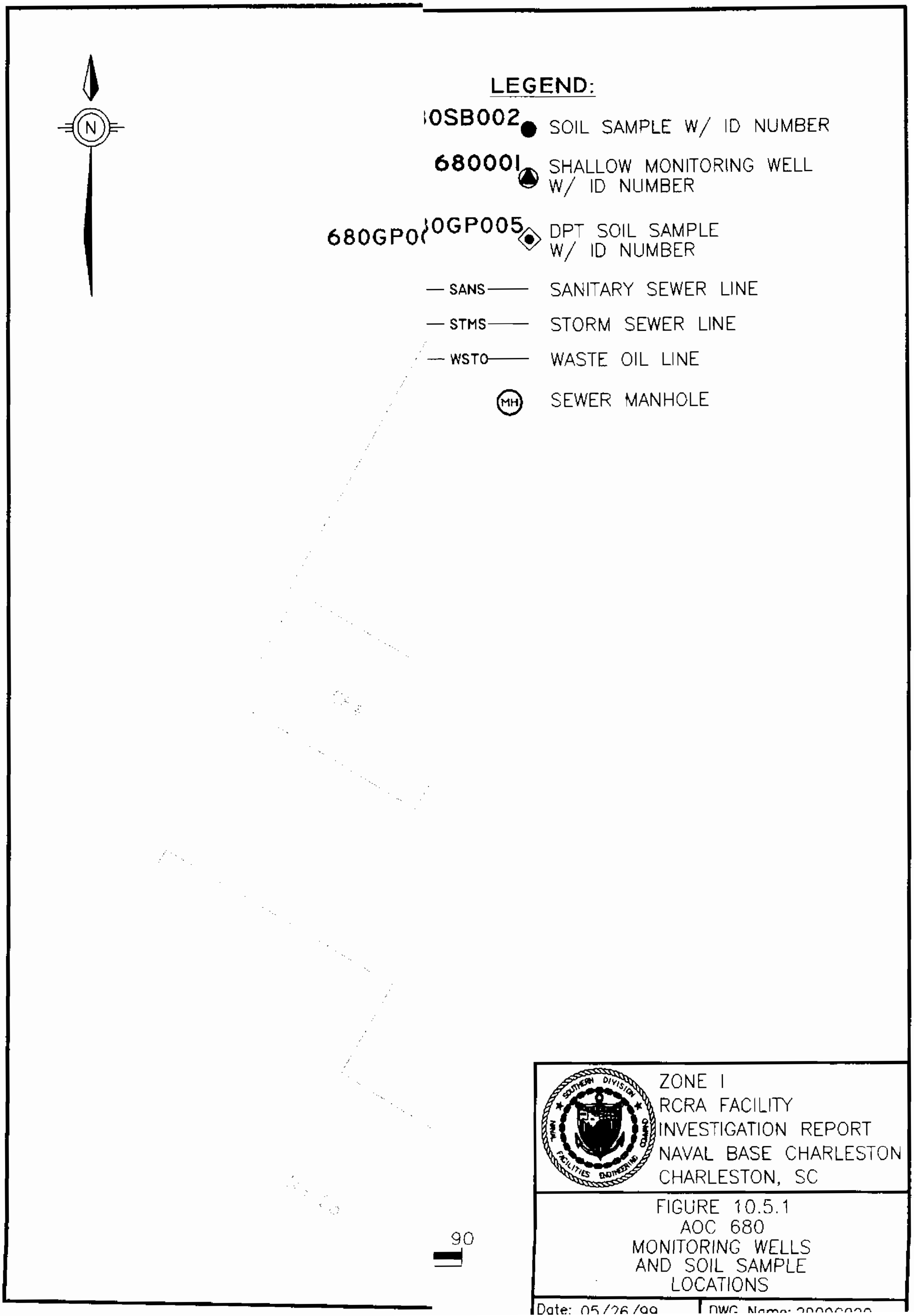
AOC 680 initially only included the former grinding room in Building NS-26, which was reportedly used to repair brake components containing asbestos. Building plans from 1969 show the grinding room on the southern side of Building NS-26. Reportedly, brake repair ceased in 1970. The area once occupied by the grinding room was remodeled in 1985 and is now a short hallway to the southern entrance to the building.

Materials of concern include asbestos dust from brake repair. Air is the potential pathway of concern. Potential receptors include personnel involved with any aggressive activity that could disturb surfaces covered with asbestos.

To fulfill the CSI objectives and to confirm the presence of any contamination from onsite activities, soil and groundwater were sampled in accordance with the final RFI work plan and Section 3 of this report. Microvacuum samples were collected in the former grinding room to confirm the presence, if any, of asbestos fibers.

10.5.1 Soil Sampling and Analysis

Soil was sampled in two rounds at AOC 680 from the locations shown on Figure 10.5.1. The Final RFI work plan proposed collecting one geoprobe soil sample, and four soil samples from the upper- interval and four from the lower- interval. Four proposed upper- interval samples and three of the four proposed lower- interval soil samples were collected. One lower-interval sample was not collected because the water table was encountered at less than 5 bgs. All samples were submitted for analysis at DQO Level III for VOCs, SVOCs, and metals. Two samples selected as duplicates were analyzed at DQO Level IV for Appendix IX analytical parameters, which


LEGEND:
SOIL SAMPLE W/ ID NUMBER
SHALLOW MONITORING WELL W/ ID NUMBER
DPT SOIL SAMPLE W/ ID NUMBER
SANS SANITARY SEWER LINE
STMS STORM SEWER LINE
WSTO WASTE OIL LINE
MH SEWER MANHOLE
680001
680GP005
90
ZONE I
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, SC
FIGURE 10.5.1
AOC 680
MONITORING WELLS
AND SOIL SAMPLE
LOCATIONS
Date: 05/26/99

includes a more comprehensive list of VOCs and SVOCs. All samples from round two were submitted for the standard suite of parameters which include VOCs, SVOCs, pesticides, PCBs, cyanide, and metals. Table 10.5.1 summarizes the soil sampling.

Table 10.5.1
AOC 680
Soil Sampling Summary

Sampling Round	Sampling Date	Samples Collected	Sample Analyses	Comments
1	03/17/98	Geoprobe - 1 (1)	VOCs, SVOCs	
	04/08/98	Upper - 4 (4)	VOCs, SVOCs	
		Lower - 3 (4)	VOCs, SVOCs	
		Duplicates - 2	VOCs, SVOCs	
2	09/24/98	Upper - 1 Lower - 1	Standard Suite	Additional boring installed as result of waste oil UST removal

Notes:
( ) = Parenthesis indicate numbers of samples proposed
Standard Suite = VOCs, SVOCs, metals, cyanide, pesticides, and PCBs at DQO Level IV.

10.5.2 Nature and Extent of Contamination in Soil

Organic compound analytical data for soil are summarized in Table 10.5.2. Inorganic analytical data for soil are summarized in Table 10.5.3. Table 10.5.4 summarizes all analytes detected in soil at AOC 680. Appendix D is a complete analytical data report for all samples collected in Zone I.

Volatile Organic Compounds in Soil

Nine VOCs were detected in AOC 680 surface soil samples. The RBC was not exceeded in any surface soil sample. Five VOCs were detected in subsurface samples. 1,2-Dichloroethene (total), in the subsurface soil exceeded its SSL of 200μg/kg with a result of 240μg/kg in sample 680SB00502.

Table 10.5.2
AOC 680
Organic Compound Analytical Results for Soil (μg/kg)

Parameters	Sample Interval	Detection Frequency	Detection Range	Mean	RBC (upper) SSL (lower)	Number of Samples Exceeding RBC or SSL
Volatile Organic Compounds (μg/kg)						
Acetone	Upper	1/6	77	77	7,800,00	0
	Lower	0/4	NA	77	8,000	0
Benzene	Upper	0/6	NA	NA	22,000	0
	Lower	3/4	0.99 - 3	1.66	15	0
Ethylbenzene	Upper	2/6	0.96 - 2.2	1.58	780,000	0
	Lower	3/4	1.1 - 8.4	4.3	6,500	0
Toluene	Upper	1/6	1.6	1.6	1,600,000	0
	Lower	3/4	2.2 - 10	5.2	6,000	0
Xylene (total)	Upper	4/6	1.5 - 10	4.1	16,000,000	0
	Lower	3/4	4.5 - 33	17.17	70,000	0
Tetrachloroethene	Upper	1/6	420	420	12,000	0
	Lower	0/4	ND	ND	30	0
Trichloroethene	Upper	1/6	140	140	58,000	0
	Lower	0/4	ND	ND	30	0
1,1-Dichloroethane	Upper	1/6	6.0	6.0	780,000	0
	Lower	0/4	ND	ND	11,000	0
1,2-Dichloroethene	Upper	1/6	41.0	41.0	7,000	0
	Lower	1/4	240	240	200	1
4-Methyl-2-Pentanone	Upper	1/6	3.0	3.0	630,000	0
	Lower	0/4	ND	ND	6,700	0
Semivolatile Organic Compounds						
BEQ	Upper	2/6	1.63 - 260	131	87	1
	Lower	1/4	4.55	4.55	1,600	0
Benzo(a)pyrene	Upper	1/6	210	210	87	1
	Lower	0/4	NA	NA	4,000	0
Benzo(a)anthracene	Upper	2/6	16 - 270	143	870	0
	Lower	1/4	19.0	19.0	800	0
Benzo(b)fluoranthene	Upper	1/6	210	210	870	0
	Lower	1/4	24.0	24.0	2,500	0
Benzo(k)fluoranthene	Upper	1/6	210	210	8,700	0
	Lower	1/4	22.0	22.0	25,000	0
Chrysene	Upper	2/6	25.0 - 270	147	87,000	0
	Lower	1/4	31.0	31.0	80,000	0
Butylbenzylphthalate	Upper	1/6	430	430	1,600,000	0
	Lower	1/4	1,200	1,200	930,000	0
Phenanthrene	Upper	1/6	28	28	230,000	0
	Lower	0/4	NA	NA	660,000	0

Table 10.5.2
AOC 680
Organic Compound Analytical Results for Soil (μg/kg)

Parameters	Sample Interval	Detection Frequency	Detection Range	Mean	RBC (upper) SSL (lower)	Number of Samples Exceeding RBC or SSL
Fluoranthene	Upper	1/6	340	340	310,000	0
	Lower	0/4	NA	NA	2,100,000	0
Pyrene	Upper	2/6	16.0 - 440	228	230,000	0
	Lower	0/4	NA	NA	2,100,000	0
bis(2-Ethylhexyl)phthalate	Upper	2/6	22.0 - 310	166	46,000	0
(BEHP)	Lower	0/4	NA	NA	1,800,000	0

Notes:
NA = Not Applicable
ND = Not detected
NL = Not listed
See Table 5.5 for organic compound screening concentrations and their sources.

Table 10.5.3
AOC 680
Inorganic Compound Analytical Results for Soil (mg/kg)

Parameters	Sample Interval	Detection Frequency	Detection Range	Mean	Background Concentration	RBC (upper) SSL (lower)	Number of Samples Exceeding RBC and Background (upper) or SSL and Background (lower)
Aluminum (Al)	Upper	1/1	8,680	8,680	27,400	7,800	0
	Lower	1/1	9,050	9,050	18,900	560,000	0
Arsenic (As)	Upper	1/1	3.6	3.6	21.6	0.43	0
	Lower	1/1	4.9	4.9	6.45	15	0
Barium (Ba)	Upper	1/1	19.2	19.2	54.2	55	0
	Lower	1/1	14.2	14.2	36	820	0
Beryllium (Be)	Upper	1/1	0.34	0.34	0.95	16	0
	Lower	1/1	0.58	0.58	0.67	32	0
Cadmium (Cd)	Upper	1/1	0.45	0.45	0.61	7.8	0
	Lower	1/1	0.67	0.67	0.54	4	0
Chromium (Cr)	Upper	1/1	24.5	24.5	34.5	39	0
	Lower	1/1	21.8	21.8	51.3	19	0
Cobalt (Co)	Upper	1/1	1.5	1.5	5.8	470	0
	Lower	1/1	2.5	2.5	3.48	990	0
Copper (Cu)	Upper	1/1	5.9	5.9	240	310	0
	Lower	1/1	3.2	3.2	11.5	5,600	0

Table 10.5.3
AOC 680
Inorganic Compound Analytical Results for Soil (mg/kg)

Parameters	Sample Interval	Detection Frequency	Detection Range	Mean	Background Concentration	RBC (upper) SSL (lower)	Number of Samples Exceeding RBC and Background (upper) or SSL and Background (lower)
Lead (Pb)	Upper	1/1	10.7	10.7	203	400	0
	Lower	1/1	5.8	5.8	12.3	400	0
Manganese (Mn)	Upper	1/1	46.7	46.7	419	160	0
	Lower	1/1	108	108	118	480	0
Mercury (Hg)	Upper	1/1	0.05	0.05	0.47	2.3	0
	Lower	1/1	0.14	0.14	ND	1	0
Nickel (Ni)	Upper	1/1	8.5	8.5	23.9	160	0
	Lower	1/1	5.8	5.8	15.7	65	0
Selenium (Se)	Upper	1/1	0.29	0.29	1.49	39	0
	Lower	0/1	ND	ND	1.77	2.6	0
Vanadium (V)	Upper	1/1	19.0	19.0	113	55	0
	Lower	1/1	24.4	24.4	38.1	3,000	0
Zinc (Zn)	Upper	1/1	35.4	35.4	206	2,300	0
	Lower	1/1	23.3	23.3	36.2	6,200	0

Notes:
NA = Not Applicable
ND = Not detected
NL = Not listed
See Table 5.6 for organic compound screening concentrations and their sources.

Table 10.5.4
AOC 680
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Volatile Organic Compounds (µg/kg)							
Acetone	680SP005	77	780000	NA	NT	8000	NA
Benzene	680SB001	ND	22000	NA	3	15	NA
	680SB002	ND			1		
	680SB004	ND			1		
1,1-Dichloroethane	680SB005	6	780000	NA	ND	11000	NA
1,2-Dichloroethene (total)	680SB005	41	70000	NA	240	200	NA
Ethylbenzene	680SB001	ND	780000	NA	8.4	6500	NA
	680SB002	0.96			1.1		
	680SB003	2.2			NT		
	680SB004	ND			3.4		
4-Methyl-2-Pentanone (MIBK)	680SB005	3	630000	NA	ND	6700	NA
Tetrachloroethene (PCE)	680SB005	420	12000	NA	ND	30	NA
Toluene	680SB001	ND	1600000	NA	10	6000	NA
	680SB002	ND			2.2		
	680SB003	1.6			NT		
	680SB004	ND			3.4		
Trichloroethene (TCE)	680SB005	140	58000	NA	ND	30	NA

Table 10.5.4
AOC 680
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Xylene (total)	680SB001	ND	16000000	NA	33	70000	NA
	680SB002	2.9			4.5		
	680SB003	10			NT		
	680SB004	1.5			14		
	680SB005	2			ND		
Semivolatile Organic Compounds (μg/kg)							
Benzo(a)pyrene Equivalents (BEQs)	680SB003	**260.4**	87	NA	NT	1600	NA
	680SB005	1.6			4.6		
Benzo(a)anthracene	680SB003	270	870	NA	NT	800	NA
	680SB005	16			19		
Benzo(a)pyrene	680SB003	**210**	87	NA	NT	4000	NA
Benzo(b)fluoranthene	680SB003	210	870	NA	NT	2500	NA
	680SB005	ND			24		
Benzo(k)fluoranthene	680SB003	210	8700	NA	NT	25000	NA
	680SB005	ND			22		
Chrysene	680SB003	270	87000	NA	NT	80000	NA
	680SB005	25			31		
Butylbenzylphthalate	680SB001	430	1600000	NA	1,200	930000	NA

Table 10.5.4
AOC 680
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
bis(2-Ethylhexyl)phthalate (BEHP)	680SB005	22	46000	NA	ND	1800000	NA
	680SP005	310			NT		
Fluoranthene	680SB003	340	310000	NA	NT	2100000	NA
Phenanthrene	680SP005	28	230000	NA	NT	660000	NA
Pyrene	680SB003	440	230000	NA	NT	2100000	NA
	680SB005	16			25		
Inorganics (mg/kg)							
Aluminum (Al)	680SB005	8680	7800	27400	9050	560000	18900
Arsenic (As)	680SB005	3.6	0.43	21.6	4.9	15	6.45
Barium (Ba)	680SB005	19.2	550	54.2	14.2	820	36
Beryllium (Be)	680SB005	0.34	16	0.95	0.58	32	0.67
Cadmium (Cd)	680SB005	0.45	7.8	0.61	0.67	4	0.54
Chromium (Cr) (total)	680SB005	24.5	39	34.5	21.8	19	51.3
Cobalt (Co)	680SB005	1.5	470	5.8	2.5	990	3.48
Copper (Cu)	680SB005	5.9	310	240	3.2	5600	11.5
Lead (Pb)	680SB005	10.7	400	203	5.8	400	12.3
Manganese (Mn)	680SB005	46.7	160	419	108	480	118
Mercury (Hg)	680SB005	0.05	2.3	0.47	0.14	1	ND
Nickel (Ni)	680SB005	8.5	160	23.9	5.8	65	15.7

Table 10.5.4
AOC 680
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Selenium (Se)	680SB005	0.3	39	1.49	ND	2.6	1.77
Vanadium (V)	680SB005	19	55	113	24.4	3000	38.1
Zinc (Zn)	680SB005	35.4	2300	206	23.3	6200	36.2

Notes:
* = Residential RBCs (THQ=0.1) were used as a reference concentration for upper interval samples. Generic soil-to groundwater SSLs (DAF=10) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996b) were used as s reference concentration for lower interval samples.

Bolded concentrations exceed the RBC or SSL and the zone background.
All background values for Zone I are based on twice the means of the grid sample concentrations. Background values for the groundwater are based on two sampling rounds in two wells at each depth.

NA - Not applicable/not available
ND - Not detected
NI - Not installed
NL - Not listed
NT - Not taken
RBC - Risk-based concentration
SSL - Soil screening level

Semivolatile Organic Compounds in Soil

Ten SVOCs were detected in surface soil samples collected at AOC 680. Of these compounds, only benzo(a)pyrene was detected at a concentration of 210 μg/kg (sample 680SB00301) that exceeded its RBC (87 μg/kg). The upper interval sample collected at 680SB003 was the only sample that contained benzo(a)pyrene. Five SVOCs were detected in subsurface soil samples. All subsurface soil SVOC detections were below their respective SSLs.

In accordance with recent cPAH guidance (USEPA *Interim Supplemental Guidance to RAGS: Region IV Bulletins, Human Health Risk Assessment, Bulletin No. 2 [USEPA 1995c])* and Section 7 of this report, BEQs were calculated for cPAHs at AOC 680. The calculated BEQ for soil sample 680SB00301 is 260.4 μg/kg, which exceeds the RBC of 87 μg/kg. No other calculated BEQs exceeded the RBC or SSL.

Inorganic Compounds in Soil

Fifteen metals were detected in the surface soil sample 680SB00501. No detected concentrations exceed the RBC and background (upper). Fourteen metals were detected in subsurface soil sample from 680SB00502. No detections exceeded the SSL and background. Metals were not analyzed in any other soil sample.

10.5.3 Groundwater Sampling and Analysis

To characterize the zone groundwater, three shallow monitoring wells were installed and sampled in accordance with an approved final RFI work plan. Three rounds of groundwater sampling were completed at AOC 680. During the first and third rounds of sampling, AOC 680 was sampled for VOCs and SVOCs at DQO Level III. Samples from round two were also sampled for metals. Table 10.5.5 summarizes the groundwater sampling at AOC 680.

Table 10.5.5
AOC 680
Groundwater Sampling Summary

Sampling Round	Sampling Date	Number of Wells	Sample Analyses	Comments
1	03/17/98 03/18/98	Geoprobe[a]	VOCs, SVOCs	One shallow and one deep sample collected.
	04/15/98	3	VOCs, SVOCs	
2	08/21/98	3	VOCs, SVOCs, metals	
3	10/19/98	1	VOCs, SVOCs	Installed and sampled 680004 only

Notes:
a = One shallow and one deep geoprobe sample was collected near the boundary of AOC 680 and AOC 679.

Figure 10.5.1 illustrates monitoring well locations. The shallow monitoring wells were installed at 12.5 feet bgs in the upper sand layer of the Wando Formation. One deep monitoring point (680GP005) was sampled only during the first round. All wells were installed in accordance with Section 3.3 of this report.

10.5.4 Nature and Extent of Contamination in Groundwater

Table 10.5.6 summarizes the organic analytical results for groundwater at AOC 680. Inorganic analytical data for shallow groundwater are summarized in Table 10.5.7. Tables 10.5.8 and 10.5.9 summarize all analytes detected in the shallow and deep groundwater respectively at AOC 680. Appendix D is a complete analytical report for all samples collected in Zone I.

Volatile Organic Compounds in Groundwater

Eight VOCs were detected in shallow groundwater at AOC 680. Sample 680GP00501 contained acetone (6800 μg/L) and 2-butanone (MEK) (310 μg/L), which exceeded their tap-water RBCs. Tetrachloroethene (PCE) exceeded is tap-water RBC in rounds one (1.4 μg/L in 680GW00201) and two (2.0 μg/L in 680GW00202). Sample 680GW002 contained Trichloroethene (TCE)

(3 µg/L), which exceeded its tap-water RBC of 1.6 µg/L. No other shallow groundwater VOCs exceeded their respective RBC.

Two VOCs, benzene and carbon disulfide, were detected in deep groundwater sample 680GP005. Benzene (0.62 µg/L) exceeded its tap-water RBC of 0.36 µg/L.

Semivolatile Organic Compounds in Groundwater

Two SVOCs, 1,2-dichlorobenzene and bis(2-ethylhexyl)phthalate (BEHP), were detected in shallow groundwater at AOC 680. Sample 680GP00501 contained BEHP (38 µg/L), which exceeded its tap-water RBC of 4.8 µg/L.

One SVOC, naphthalene, was detected in deep groundwater sample 680GP00502. It did not exceed its RBC.

Inorganic Compounds in Groundwater

Three metals (arsenic, chromium, and manganese) were detected in shallow groundwater during the second sampling round. Arsenic exceeded its RBC and shallow background in sample 680GW00102 at 51.8 µg/L. No other detections exceeded the RBC or MCL and background.

Table 10.5.6
AOC 680
Organic Analytical Results for Shallow Groundwater (µg/L)

Parameter	Sample Round	Detection Frequency	Detection Range	Mean	Tap Water RBC/MCL	Number of Samples Exceeding RBC or MCL
Volatile Organic Compounds (µg/L)						
Acetone	First	1/4	6800	6800	370/NA	1
	Second	0/3	ND	ND		0
	Third	0/1	ND	ND		0
2-Butanone (MEK)	First	1/4	310	310	190/NA	1
	Second	0/3	ND	ND		0
	Third	0/1	ND	ND		0
Carbon Disulfide	First	2/4	0.26 - 0.61	0.435	100/NL	0
	Second	0/3	ND	ND		0
	Third	0/1	ND	ND		0

Table 10.5.6
AOC 680
Organic Analytical Results for Shallow Groundwater (μg/L)

Parameter	Sample Round	Detection Frequency	Detection Range	Mean	Tap Water RBC/MCL	Number of Samples Exceeding RBC or MCL
Chlorobenzene	First	1/4	1.7	1.7	3.5/NL	0
	Second	0/3	ND	ND		0
	Third	0/1	ND	ND		0
1,1-Dichloroethane	First	1/4	0.89	0.89	80/NL	0
	Second	1/3	1.0	1.0		0
	Third	0/1	ND	ND		0
1,2-Dichloroethene (total)	First	2/4	0.63 - 1.3	0.96	5.5/NL	0
	Second	3/3	1.0 - 3.0	1.67		0
	Third	0/1	ND	ND		0
Tetrachloroethene	First	2/4	0.64 - 1.4	1.02	1.1/5	1
	Second	1/3	2.0	2.0		1
	Third	0/1	ND	ND		0
Trichloroethene	First	1/4	0.85	0.85	1.6/5	0
	Second	1/3	3.0	3.0		1
	Third	0/1	ND	ND		0
Semi-volatile Organic Compounds (μg/L)						
Bis(2-ethylhexyl)phthalate (BEHP)	First	1/4	38.0	38.0	4.8/NL	1
	Second	0/3	ND	ND		0
	Third	0/1	ND	ND		0
1,2-Dichlorobenzene	First	0/4	ND	ND	6.4/600	0
	Second	1/3	1.0	1.0		0
	Third	0/1	ND	ND		0

Notes:
NL = Not Listed
NA = Not Applicable
ND = Not Detected
See Table 5.5 for organic screening concentrations and their sources.

Table 10.5.7
AOC 680
Inorganic Analytical Results for Groundwater (μg/L)

Parameter	Sample Round	Detection Frequency	Detection Range	Mean	Tap Water RBC/MCL	Shallow Groundwater Background	Number of Samples Exceeding Lower of RBC or MCL and Background
Arsenic (As)	Second*	2/3	3.1 - 51.8	27.5	0.045/50	23	1
Chromium (Cr)	Second	1/3	8.2	8.2	18/100	14.3	0
Manganese (Mn)	Second	3/3	20.5 - 82.3	55.2	73/NL	5,430	0

Notes:
* - Only sampled for metals in the second round of sampling
NL = Not Listed
NA = Not Applicable
ND = Not Detected
See Table 5.6 for inorganic screening concentrations and their sources.

Table 10.5.8
AOC 680
Analytes Detected in Shallow Groundwater (μg/L)

Parameters	Location	1st Round	2nd Round	3rd Round	Tap Water RBC*	MCL/SMCL*	Shallow Background
Volatile Organic Compounds							
Acetone	680GP005	**6800**	NT	NT	370	NA	
2-Butanone (MEK)	680GP005	**310**	NT	NT	190	NA	
Carbon disulfide	680GW003	0.61	ND	ND	100	NA	
	680GP005	0.26	NT	NT			
Chlorobenzene	680GW002	1.7	ND	ND	3.5	NA	
1,1-Dichloroethane	680GW002	0.89	1	ND	80	NA	
1,2-Dichloroethene (total)	680GW001	1.3	1	ND	5.5	NA	
	680GW002	0.63	1	ND			
	680GW003	ND	3	ND			
Tetrachloroethene (PCE)	680GW002	**1.4**	**2**	ND	1.1	5	
	680GP005	0.64	ND	ND			
Trichloroethene (TCE)	680GW002	0.85	**3**	ND	1.6	5	
Semivolatile Organic Compounds							
1,2-Dichlorobenzene	680GW002	ND	1	ND	6.4	600	
bis(2-Ethylhexyl)phthalate (BEHP)	680GP005	**38**	NT	NT	4.8	NA	
Inorganics							
Arsenic (As)	680GW001	NT	**51.8**	NT	0.045	50	23
	680GW002	NT	3.1	NT			

Table 10.5.8
AOC 680
Analytes Detected in Shallow Groundwater ($\mu g/L$)

Parameters	Location	1st Round	2nd Round	3rd Round	Tap Water RBC*	MCL/SMCL*	Shallow Background
Chromium (Cr) (total)	680GW001	NT	8.2	NT	18	100	14.3
Manganese (Mn)	680GW001	NT	62.8	NT	73	NL	5430
	680GW002	NT	**82.3**	NT			
	680GW003	NT	20.5	NT			

Notes:
* = Tap Water RBCs (THQ=0.1) from *Risk-Based Concentration Table* (USEPA, October 22, 1997), and MCLs/SMCLs from *Drinking Water Regulations and Health Advisories* (USEPA, 1996e)

Bolded concentrations exceed the RBC and the zone background
All background values for Zone I are based on twice the means of the grid sample concentrations. Background values for the groundwater are based on two sampling rounds in two wells at each depth

NA - Not applicable/not available
ND - Not detected
NI - Not installed
NL - Not listed
NT - Not taken
RBC - Risk-based Concentration
MCL - Maximum Concentration Levels
SMCL - Secondary Maximum Concentration Levels

Table 10.5.9
AOC 680
Analytes Detected in Deep Groundwater (μg/l)

Parameters	Location	1st Round	2nd Round	3rd Round	Tap Water RBC*	MCL/SMCL*	Shallow Background
Volatile Organic Compounds							
Benzene	680GP005	ND	**0.62**	ND	0.36	5	
Carbon disulfide	680GP005	ND	4.8	ND	100	NA	
Semivolatile Organic Compounds							
Naphthalene	680GP005	ND	9.5	ND	150	NA	

Notes:
* = Tap Water RBCs (THQ=0.1) from *Risk-Based Concentration Table* (USEPA, October 22, 1997), and MCLs/SMCLs from *Drinking Water Regulations and Health Advisories* (USEPA, 1996e)

Bolded concentrations exceed the RBC and the zone background
All background values for Zone I are based on twice the means of the grid sample concentrations. Background values for the groundwater are based on two sampling rounds in two wells at each depth

NA - Not applicable/not available
ND - Not detected
NI - Not installed
NL - Not listed
NT - Not taken
RBC - Risk-based Concentration
MCL - Maximum Concentration Levels
SMCL - Secondary Concentration Levels

A deep groundwater sample was only collected in the first sample round.

10.5.5 Microvacuum Sampling and Analysis

Microvacuum sampling was performed at AOC 680 from horizontal surfaces in the hallway and in the ship fitters shop area in Building NS-26. The Final RFI work plan proposed collecting nine to 12 dust samples for asbestos analysis. Microvacuum samples were collected as stated in the site-specific sampling and analysis plan in the Zone I work plan. Nine samples were collected. Samples were submitted for bulk asbestos analysis by phase-contrast light microscopy. Table 10.5.10 summarizes the sampling at AOC 680.

Table 10.5.10
AOC 680
Dust Sampling Summary

Samples Proposed	Samples Collected	Analyses Proposed	Analyses Collected	Deviation
9 to 12	9	Asbestos	Asbestos	ND

Note:
ND = No Deviation

10.5.6 Nature and Extent of Contamination in Dust

No asbestos fibers were detected in the samples. Appendix D contains a complete analytical report for all samples collected at AOC 680.

10.5.7 Fate and Transport

AOC 680 includes Building NS-26 and associated former grinding room/brake repair area. Building NS-26 was part of the Navy's Shore Intermediate Activity (SIMA) complex. The building was constructed in 1958 and renovated in 1985. Structures associated with NS-26 include several storage sheds and steel storage trailers. Environmental media sampled as part of the as AOC 680 investigation include surface soil, subsurface soil, and shallow groundwater. Potential constituent migration pathways investigated include soil to groundwater, groundwater migration, and emission of volatiles from surface soil to air. Additionally, an effort to preliminarily address the issue of discharge to surface water receptors was made. This assessment is intended to serve as a qualitative analysis using the analytical data for these media coupled with the current understanding of hydrogeological conditions at the site.

10.5.7.1 Soil to Groundwater Cross-Media Transport

Tables 10.5.11 and 10.5.12 compare maximum detected organic and inorganic constituent concentrations in surface soil and subsurface soil samples respectively to risk-based soil screening levels considered protective of groundwater. To provide a conservative screen, generic soil screening levels are used; leachate entering the aquifer is assumed to be diluted by a ratio of 10:1, with no attenuation of constituents in soil (DAF=10).

Three organic compounds – 1,2-Dichloroethene tetrachloroethene (1,2 DCE), trichloroethene (PCE), and TCE – were present in soil above their respective screening values. 1,2 DCE was present at greater concentration in the subsurface, suggesting that Zone I may be a relict of TCE degradation. Both PCE and TCE were non-detect in subsurface soil, but both were present in groundwater, suggesting that calculated leachability values may be too high. The distribution of chlorinated solvents was spatially limited, occurring in only 1 of 6 sample locations. The presence of chlorinated solvents is consistent with past site activities, namely metal grinding and brake cleaning and repair. The presence of these parameters in groundwater validates the pathway with respect to them. Figures 10.5.2, 10.5.3, and 10.5.4 present 1,2 DCE, PCE, and TCE concentrations detected at AOC 680 respectively.

One inorganic – chromium – was present in soil above its screening value. It was present in both surface and subsurface soil at one location, as well as in groundwater. Figure 10.5.5 presents the chromium concentrations detected at AOC 680. Notably, it was at concentrations in soil below the zone-wide background concentrations. Furthermore, the presence of chromium is not expected to be associated with the past site activities. However, the presence of CR in soil and groundwater validates the pathway with respect to this parameter.

Table 10.5.11
Organic Chemicals Detected in Surface Soil, Subsurface Soil, Sediment, and Shallow Groundwater
Comparison to Cross-media SSLs, Tap Water RBCs, and Saltwater Surface Water Chronic Screening Levels
AOC 680
Charleston Naval Complex
Charleston, South Carolina

Parameter	Maximum Concentration Surface Soil	Maximum Concentration Subsurface Soil	Maximum Concentration Sediment	Maximum Concentration Shallow GW	Screening Concentration Soil to GW SSL	Screening Concentration Soil to Air SSL	Screening Concentration Tap Water RBC	Screening Concentration Saltwater Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Volatilization Potential	Groundwater Migration Concern	Surface Water Migration Concern
Volatile Organic Compounds														
Acetone	77	ND	NA	ND	8000	1.0E+08	3700	NA	UG/KG	UG/L	NO	NO	NO	NO
Benzene c	ND	3	NA	ND	15	800	0.36	109	UG/KG	UG/L	NO	NO	NO	NO
Carbon disulfide	ND	ND	NA	0.61	16000	720000	1000	NA	UG/KG	UG/L	NO	NO	NO	NO
Chlorobenzene	ND	ND	NA	1.7	700	130000	35	105	UG/KG	UG/L	NO	NO	NO	NO
1,1-Dichloroethane	6	ND	NA	1	11000	1300000	800	NA	UG/KG	UG/L	NO	NO	NO	NO
1,2-Dichloroethene (total)	41	240	NA	3	200	1100000	55	NA	UG/KG	UG/L	YES	NO	NO	NO
Ethylbenzene	2.2	8.4	NA	ND	6500	400000	1300	4.3	UG/KG	UG/L	NO	NO	NO	NO
4-Methyl-2-Pentanone (MIBK)	3	ND	NA	ND	6700 a	NA	2900	NA	UG/KG	UG/L	NO	NO	NO	NO
Tetrachloroethene (PCE) c	420	ND	NA	2	30	11000	1.1	45	UG/KG	UG/L	YES	NO	YES	NO
Trichloroethene (TCE) c	140	ND	NA	3	30	5000	1.6	NA	UG/KG	UG/L	YES	NO	YES	NO
Xylene (total)	10	33	NA	ND	70000 a	410000	12000	NA	UG/KG	UG/L	NO	NO	NO	NO
Semivolatile Organic Compounds														
Benzo(a)pyrene Equivalents	260	4.55	NA	ND	1600 a	NA	0.0092	NA	UG/KG	UG/L	NO	NO	NO	NO
Benzo(a)anthracene c	270	19	NA	ND	800	NA	0.092	NA	UG/KG	UG/L	NO	NO	NO	NO
Benzo(a)pyrene c	210	ND	NA	ND	4000	NA	0.0092	NA	UG/KG	UG/L	NO	NO	NO	NO
Benzo(b)fluoranthene c	210	24	NA	ND	2500	NA	0.092	NA	UG/KG	UG/L	NO	NO	NO	NO
Benzo(k)fluoranthene c	210	22	NA	ND	25000	NA	0.92	NA	UG/KG	UG/L	NO	NO	NO	NO
Chrysene c	270	ND	NA	ND	80000	NA	9.2	NA	UG/KG	UG/L	NO	NO	NO	NO
Butylbenzylphthalate	430	1200	NA	ND	930000	930000	730	29.4	UG/KG	UG/L	NO	NO	NO	NO
1,2-Dichlorobenzene	ND	ND	NA	1	8500	560000	6.4	19.7	UG/KG	UG/L	NO	NO	NO	NO
bis(2-Ethylhexyl)phthalate (BEHP) c	310	ND	NA	38	1800000	31000000	4.8	NA	UG/KG	UG/L	NO	NO	YES	NO
Fluoranthene	340	ND	NA	ND	2100000	NA	1500	1.6	UG/KG	UG/L	NO	NO	NO	NO
Phenanthrene	28	ND	NA	ND	660000 a	NA	1100	NA	UG/KG	UG/L	NO	NO	NO	NO
Pyrene	440	ND	NA	ND	2100000	NA	1100	NA	UG/KG	UG/L	NO	NO	NO	NO

Notes:
Sources of screening concentrations appear in Table 5.5
Explanations of fate and transport screening procedures appear in Section 6.2.
Frequency and range of detections, average detected concentrations, and number of screening concentration exceedances appear in Tables 10.5.2 and 10.5.6.

a - Calculated soil to groundwater SSL value (See Table 6.2)
b - Based on surrogate compound; see Table 5.5
c - Carcinogenic
GW - Groundwater

NA - Not applicable/not available
ND - Not detected
RBC - Risk-based concentration
SSL - Soil screening level

NG/KG - Nanograms per kilogram
UG/KG - Micrograms per kilogram
PG/L - Picograms per liter
UG/L - Micrograms per liter

Table 10.5.12
Inorganic Chemicals Detected in Surface Soil, Subsurface Soil, Sediment, and Shallow Groundwater
Comparison to Cross-media SSLs, Tap Water RBCs, Saltwater Surface Water Chronic Screening Levels, and Background Values
AOC 680
Charleston Naval Complex
Charleston, South Carolina

Parameter	Maximum Concentration Surface Soil	Subsurface Soil	Sediment	Shallow GW	Screening Concentration Soil to GW SSL	Soil Backgroun	Soil to Air SSL	Tap Water RBC	Shallow GW Background	Saltwater Surf. Wtr Chronic	Soil Units	Water Units	Leaching Potential	Fugitive Particulate Inhalation Concern	Ground-water Migration Concern	Surface Water Migration Concern
Inorganic Chemicals																
Aluminum (Al)	8680	9050	NA	ND	560000 a	27400	NA	37000	1440	NA	MG/KG	UG/L	NO	NO	NO	NO
Arsenic (As) c	3.6	4.9	NA	51.8	15	21.6	750	0.045	23	36	MG/KG	UG/L	NO	NO	YES	YES
Barium (Ba)	19.2	14.2	NA	ND	820	54.2	690000	2600	110	NA	MG/KG	UG/L	NO	NO	NO	NO
Beryllium (Be)	0.34	0.58	NA	ND	32	0.95	1300	73	1.1	NA	MG/KG	UG/L	NO	NO	NO	NO
Cadmium (Cd)	0.45	0.67	NA	ND	4	0.61	1800	18	NA	9.3	MG/KG	UG/L	NO	NO	NO	NO
Chromium (Cr) (total)	24.5	21.8	NA	8.2	19	51.3	270	180	14.3	50	MG/KG	UG/L	YES	NO	NO	NO
Cobalt (Co)	1.5	2.5	NA	ND	990 a	5.8	NA	2200	2.2	NA	MG/KG	UG/L	NO	NO	NO	NO
Copper (Cu)	5.9	3.2	NA	ND	5600 a	240	NA	1500	4.4	2.9	MG/KG	UG/L	NO	NO	NO	NO
Lead (Pb)	10.7	5.8	NA	ND	400	203	400	15	4.4	8.5	MG/KG	UG/L	NO	NO	NO	NO
Manganese (Mn)	46.7	108	NA	82.3	480 a	419	NA	730	5430	NA	MG/KG	UG/L	NO	NO	NO	NO
Mercury (Hg)	0.05	0.14	NA	ND	1	0.47	10	11	NA	0.025	MG/KG	UG/L	NO	NO	NO	NO
Nickel (Ni)	8.5	5.8	NA	ND	65	23.9	13000	730	13.3	8.3	MG/KG	UG/L	NO	NO	NO	NO
Selenium (Se)	0.29	ND	NA	ND	2.6	1.77	NA	180	ND	71	MG/KG	UG/L	NO	NO	NO	NO
Vanadium (V)	19	24.4	NA	ND	3000	113	NA	260	14	NA	MG/KG	UG/L	NO	NO	NO	NO
Zinc (Zn)	35.4	23.3	NA	ND	6200	206	NA	11000	24.4	86	MG/KG	UG/L	NO	NO	NO	NO

Notes:
Sources of screening concentrations appear in Table 5.6
Explanations of fate and transport screening procedures appear in Section 6.2.
Frequency and range of detections, average detected concentrations, and number of screening concentration exceedances appear in Tables 10.5.3 and 10.5.7.

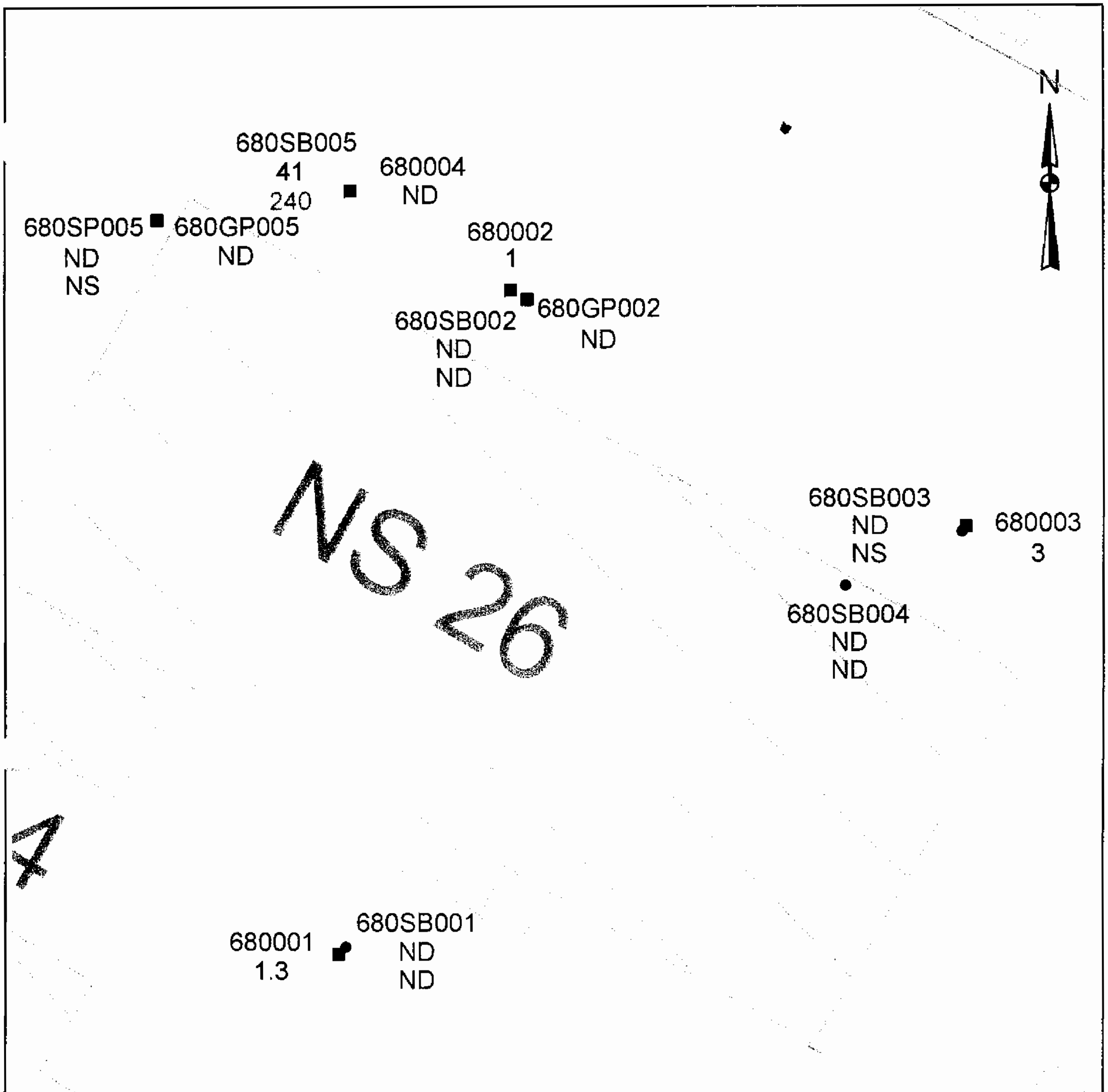
Background values for soil are shown for comparison purposes only.
Maximum groundwater concentrations are screened against the greater of tap water RBCs or corresponding background values to determine groundwater migration concern.

a - Calculated soil to groundwater SSL value (See Table 6.2)
c - Carcinogenic
GW - Groundwater
NA - Not available/Not applicable
ND - Not detected
RBC - Risk-based concentration
SSL - Soil screening level
MG/KG - Milligrams per kilogram
UG/L - Micrograms per liter

10.5.7.2 Groundwater Migration to Surface Water Cross-Media Transport

Tables 10.5.11 and 10.5.12 compare maximum detected organic and inorganic constituent concentrations respectively, in shallow groundwater samples to risk-based concentrations for drinking water, and to chronic ambient saltwater quality criteria values for the protection of aquatic life (saltwater surface water chronic screening values). For inorganics, maximum concentrations in groundwater are screened against the greater of (a) risk-based drinking water concentrations or (b) corresponding background reference concentrations for groundwater, as well as to the saltwater surface water chronic values. To provide a conservative screening, no attenuation or dilution of constituents in groundwater is assumed before comparison to the relevant standards. It should be noted at the beginning of this discussion that the risk-based pathway for shallow groundwater is currently an invalid pathway simply because there is no human consumption of the groundwater, e.g. there is no end-use receptor. This comparison is made for screening only, and to develop strategies for log-term management of the groundwater should an area containing deleterious levels be identified.

Three organic compounds - PCE, TCE, and bis(2-ethylhexyl)phthalate (BEHP) - were present in groundwater` at concentrations that exceeded their respective screening values. All three exhibited only slight exceedances, and all three were detected only in the first quarter of sampling and were non-detect in the third quarter sampling. The inconsistent detection of these parameters coupled with their presence in surface soil and absence in subsurface soil, suggests that their presence in groundwater may be a result of drilling carrydown. Again, the presence of solvents is not inconsistent with past site activities, but BEHP's presence is suspect (it is a common lab artifact). Given their absence in the most recent sampling effort, the pathway is considered invalid with respect to these parameters. Detected concentrations of PCE and TCE are presented in Figures 10.5.3 and 10.5.4. Figure 10.5.6 presents concentrations of BEHP detected at AOC 680.



LEGEND

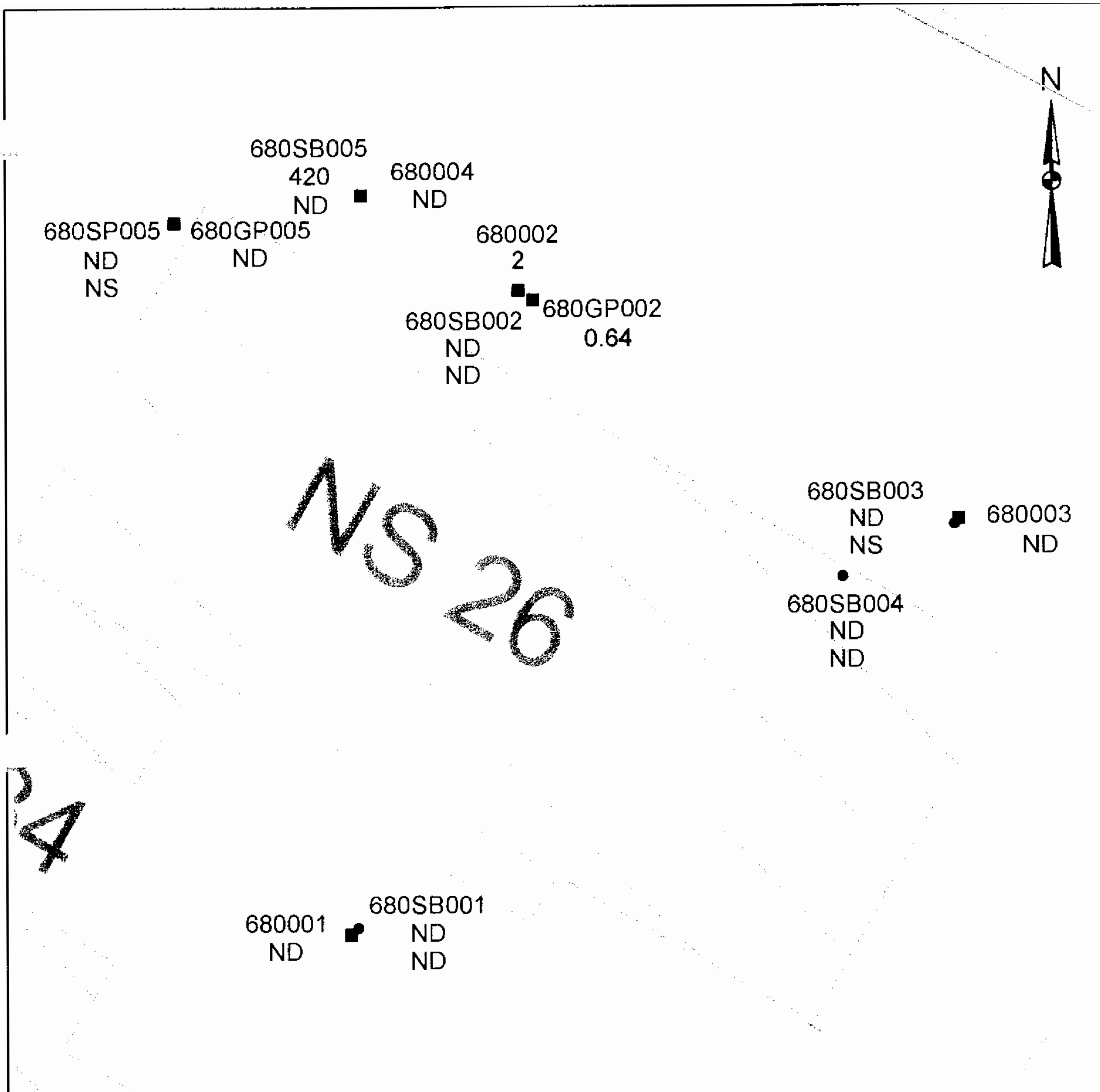
MONITORING WELL LOCATION
ZONE I SOIL BORING LOCATION
12.30 ZONE I SURFACE SOIL CONC. (UG/KG)
12.30 ZONE I SUBSURFACE SOIL CONC. (UG/KG)
12.30 MAXIMUM QUARTERLY GW CONC. (UG/L)
NS NO SAMPLE TAKEN
ND NON DETECT

SCALE
0 20 40 60 80 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.5.2
ZONE I
AOC 680
1,2-DICHLOROETHENE(TOTAL)
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=NA RBC=70000 UG/KG SSL=200 UG/KG



LEGEND

■ MONITORING WELL LOCATION
● ZONE I SOIL BORING LOCATION
12.30 ZONE I SURFACE SOIL CONC. (UG/KG)
12.30 ZONE I SUBSURFACE SOIL CONC. (UG/KG)
12.30 MAXIMUM QUARTERLY GW CONC. (UG/L)
NS NO SAMPLE TAKEN
ND NON DETECT

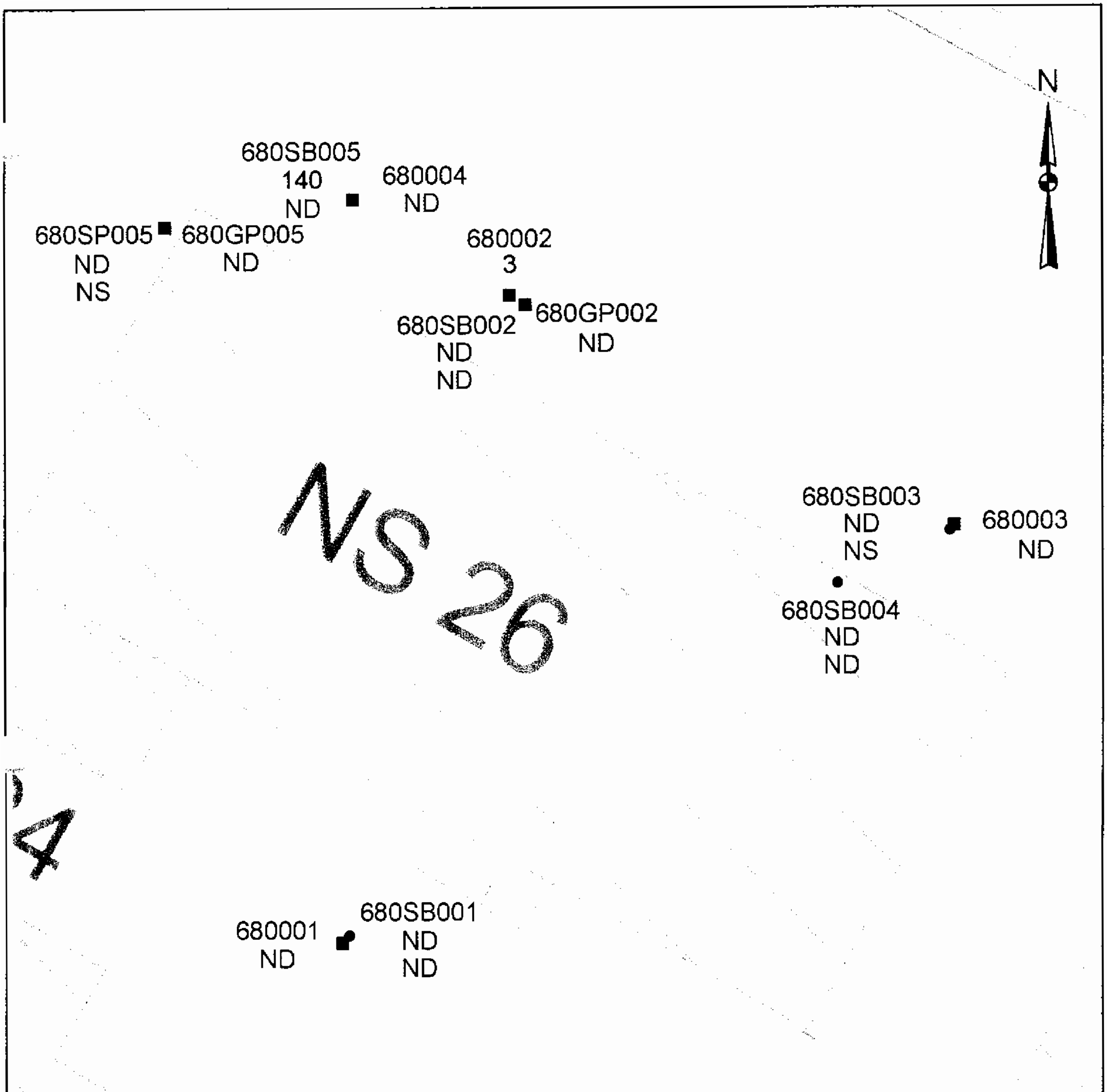
SCALE

0 20 40 60 80 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.5.3
ZONE I
AOC 680
TETRACHLOROETHENE
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=5 UG/L RBC=12000 UG/KG SSL=30 UG/KG



LEGEND

■	MONITORING WELL LOCATION
●	ZONE I SOIL BORING LOCATION
12.30	ZONE I SURFACE SOIL CONC. (UG/KG)
12.30	ZONE I SUBSURFACE SOIL CONC. (UG/KG)
12.30	MAXIMUM QUARTERLY GW CONC. (UG/L)
NS	NO SAMPLE TAKEN
ND	NON DETECT

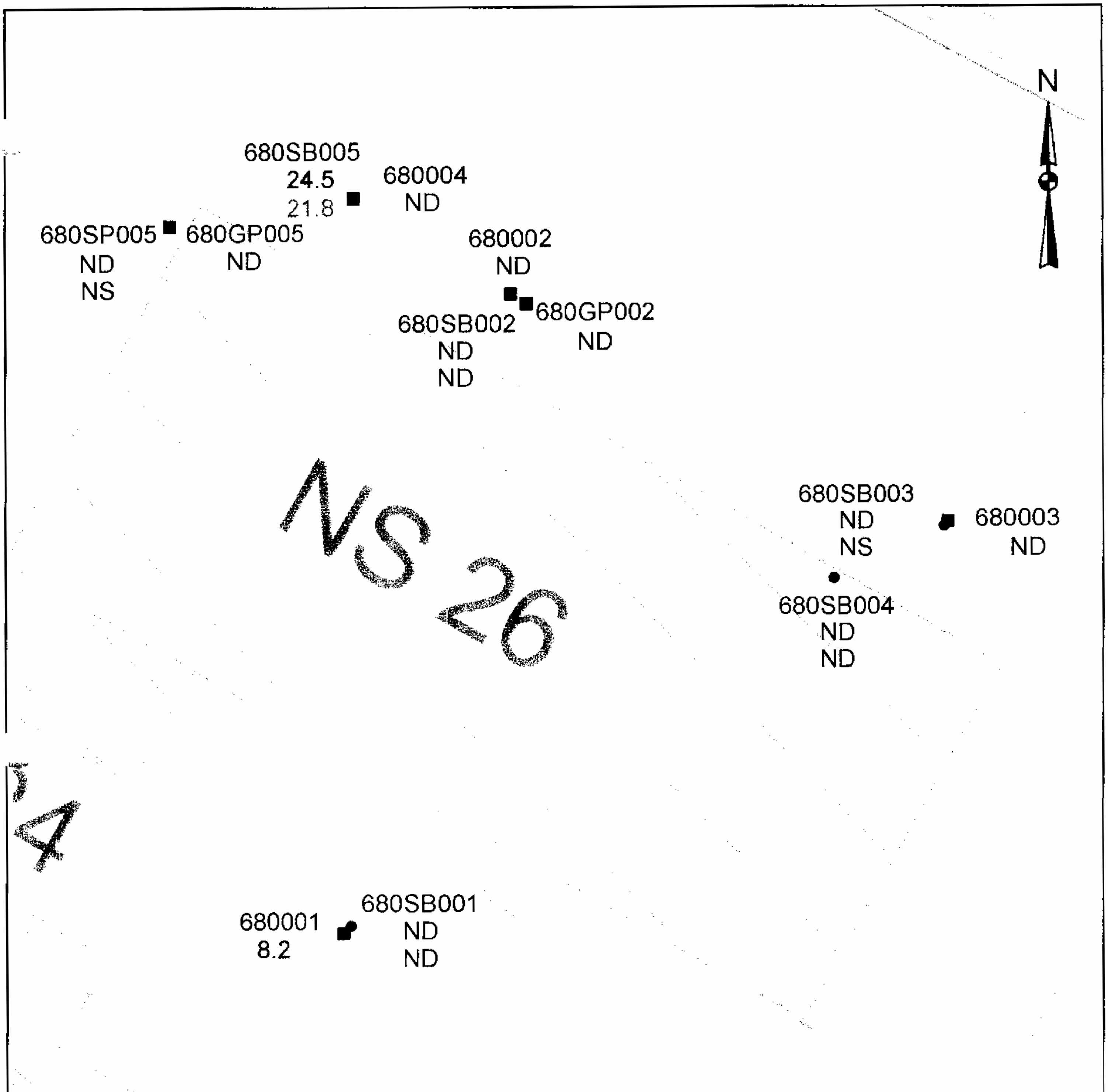
SCALE

0 20 40 60 80 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.5.4
ZONE I
AOC 680
TRICHLOROETHENE
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=5 UG/L RBC=58000 UG/KG SSL=30 UG/KG



LEGEND

■	MONITORING WELL LOCATION
●	ZONE I SOIL BORING LOCATION
12.30	ZONE I SURFACE SOIL CONC. (MG/KG)
12.30	ZONE I SUBSURFACE SOIL CONC. (MG/KG)
12.30	MAXIMUM QUARTERLY GW CONC. (UG/L)
NS	NO SAMPLE TAKEN
ND	NON DETECT

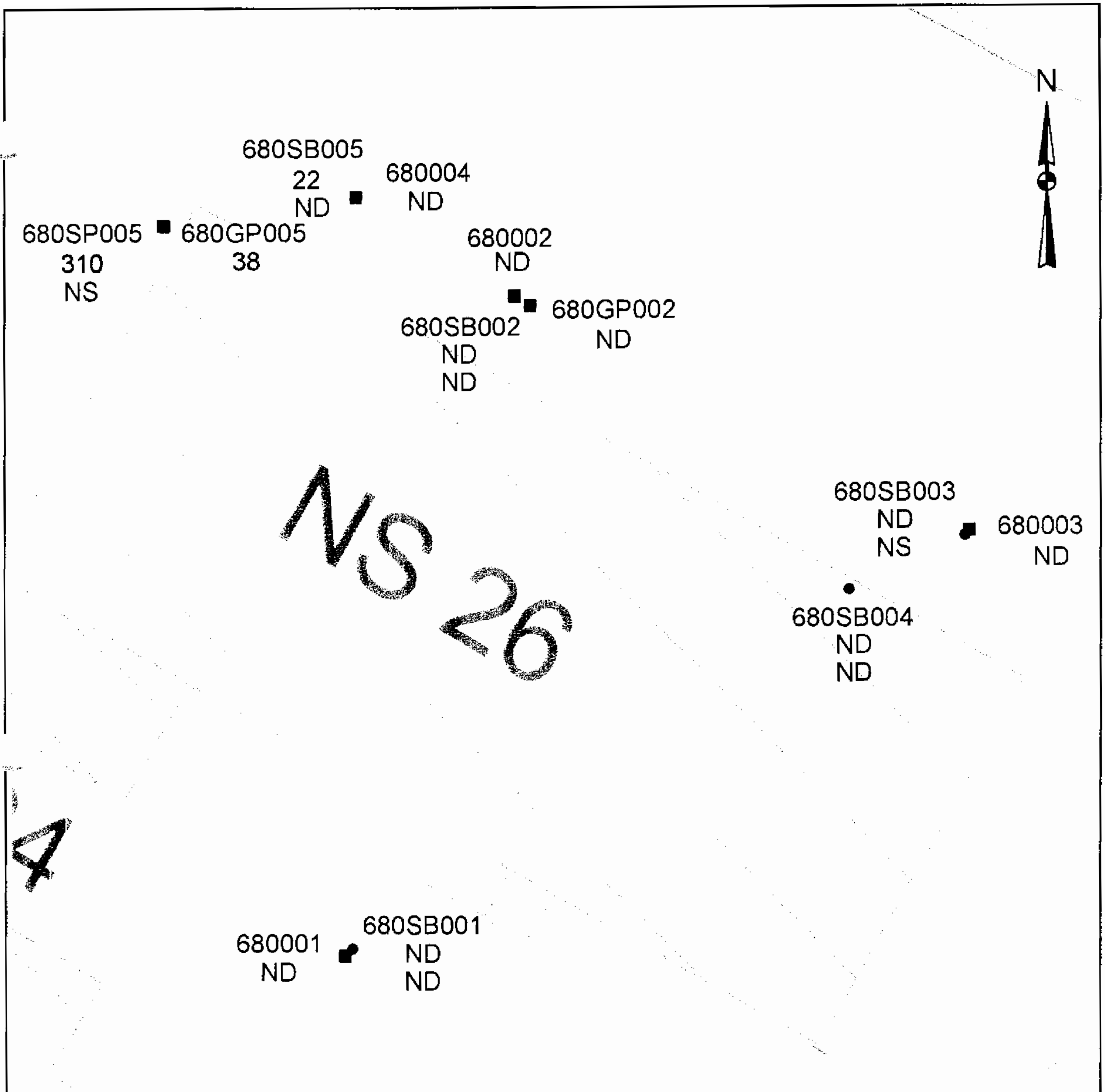
SCALE

0 20 40 60 80 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.5.5
ZONE I
AOC 680
CHROMIUM
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=100 UG/L RBC=39 MG/KG SSL=19 MG/KG



LEGEND

■	MONITORING WELL LOCATION
●	ZONE I SOIL BORING LOCATION
12.30	ZONE I SURFACE SOIL CONC. (UG/KG)
12.30	ZONE I SUBSURFACE SOIL CONC. (UG/KG)
12.30	MAXIMUM QUARTERLY GW CONC. (UG/L)
NS	NO SAMPLE TAKEN
ND	NON DETECT

SCALE

0 20 40 60 80 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.5.6
ZONE I
AOC 680
BEHP
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=NA RBC=46000 UG/KG SSL=1800000 UG/KG

One inorganic – arsenic – was present in groundwater significantly above its RBC. Arsenic is not expected to be associated with past site activities, but it is a common constituent in zone-wide groundwater. This would suggest that leaching from native soil and aquifer matrix may be the mechanism releasing arsenic to groundwater, as opposed to an actual waste release. The presence of arsenic in groundwater at concentrations approximately twice the background validates the pathway, but it is not expected to be significant due to non-use of the resource. Figure 10.5.7 presents concentrations of arsenic detected at AOC 680.

One inorganic constituent – arsenic – was present in groundwater above its screening value for surface water migration. It was detected at approximately twice its background for shallow groundwater, but was not above its SSL in surface or subsurface soil. Additionally, arsenic is not expected to be associated with past site activities, and arsenic is a common constituent in zone-wide soil and groundwater samples. These lines of evidence suggest that either the calculated SSL for arsenic is too high given site conditions, or that arsenic is being imparted through leaching from deeper vadose zone lithologies and/or aquifer matrix. The proximity of the Cooper River and the groundwater flow direction indicate that the River is a potential receptor of groundwater discharge, but attenuation along the flowpath and dilution upon discharge to the River will likely reduce concentrations of arsenic to insignificant levels.

10.5.7.3 Soil to Air Cross-Media Transport

No surface soil parameters were present above their respective screening values for the soil to air pathway, thus the pathway is considered invalid for this AOC.

10.5.7.4 Fate and Transport Summary

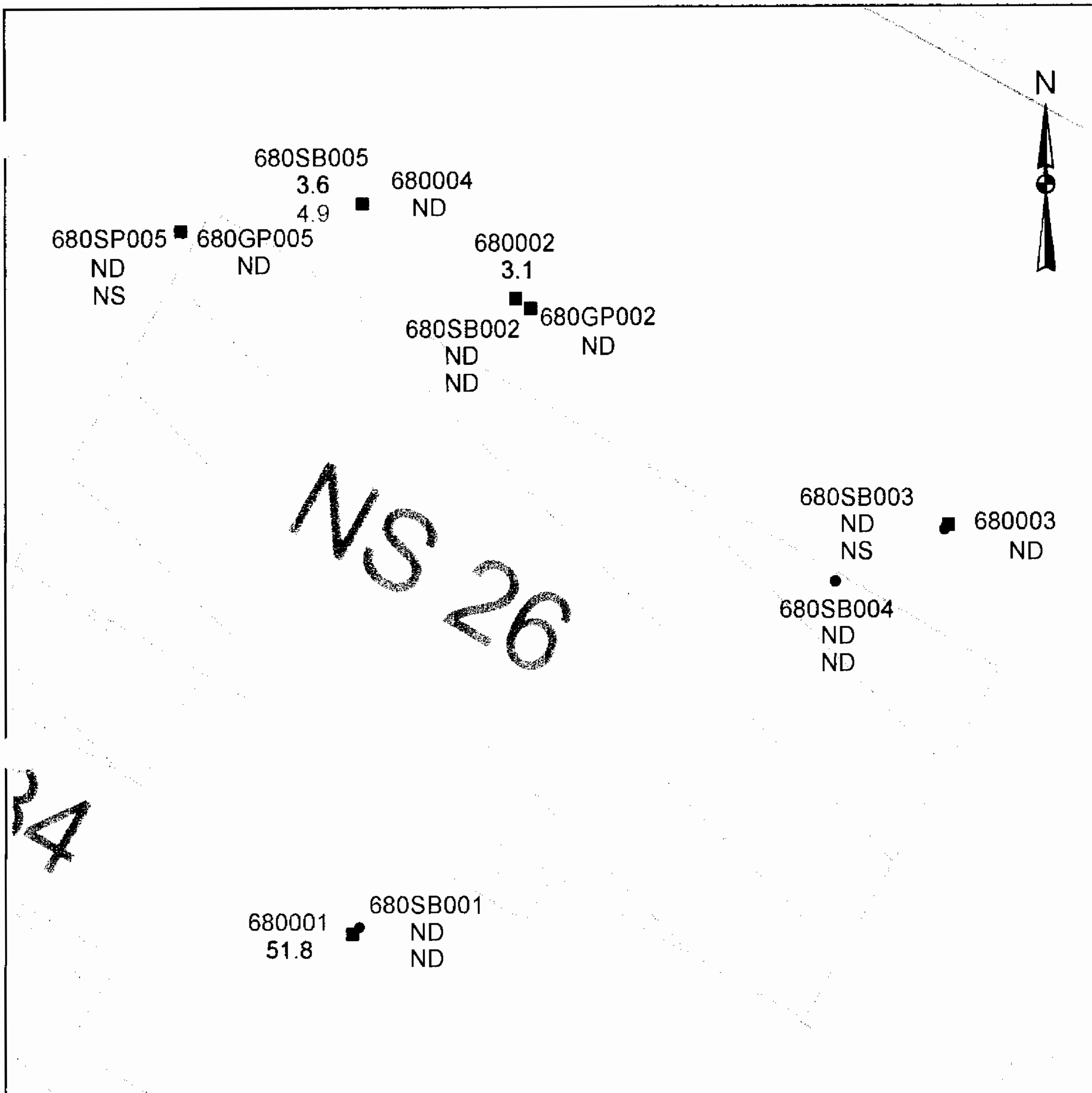
1,2 DCE, PCE, TCE, and chromium were present in soil above their respective SSL. PCE and TCE were ND in subsurface soil but were present in groundwater; 1,2 DCE exhibited an increase in subsurface soil (possibly as a degradation product of TCE); and chromium, although above its

SSL, was below background in both surface and subsurface soil. The presence of solvents is not inconsistent with past site activities. The occurrence of these constituents in both soil and groundwater validates the pathway.

PCE, TCE, BEHP, and arsenic were present in site groundwater at concentrations above their respective RBCs. The organics were present in surface soil media, absent in subsurface soil, and were all non-detect during the most recent groundwater sampling. This would suggest their occurrence in groundwater is due to drilling carry-down, and the pathway with respect to organics is considered invalid due to both their absence in groundwater and non-use of the resource. The highest concentration of arsenic was approximately twice its shallow background; arsenic is not expected to be associated with past site activities, but it is a common constituent in zone soil and groundwater. This would suggest that arsenic is being imparted to groundwater through leaching of deeper vadose zone soil or aquifer matrix. The presence of arsenic above RBCs validates the pathway, but it is not considered significant due to non-use of the resource.

Arsenic exceeded its surface water screening criteria in shallow groundwater. As previously noted, the source of arsenic is presumed to be deeper vadose zone media or aquifer matrix. The Cooper River is a potential receptor based on groundwater flow and proximity. Therefore the pathway is considered valid, but given the arsenic concentrations and the potential for attenuation along the flowpath and dilution upon discharge, it is not expected to be significant.

Given the absence of surface soil exceedances for inhalation screening values, the soil to air pathway is considered invalid.



LEGEND

■	MONITORING WELL LOCATION
●	ZONE I SOIL BORING LOCATION
12.30	ZONE I SURFACE SOIL CONC. (MG/KG)
12.30	ZONE I SUBSURFACE SOIL CONC. (MG/KG)
12.30	MAXIMUM QUARTERLY GW CONC. (UG/L)
NS	NO SAMPLE TAKEN
ND	NON DETECT

SCALE

0 20 40 60 80 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.5.7
ZONE I
AOC 680
ARSENIC
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=50 UG/L RBC=.43 MG/KG SSL=15 MG/KG

10.5.8 Human Health Risk Assessment

10.5.8.1 Site Background and Investigative Approach

The purpose of the investigation at AOC 680 was the assessment of soil and groundwater potentially affected by past activities onsite.

AOC 680 includes Building NS-26 and associated former grinding room/brake repair area. Building NS-26 was part of the Navy's Shore Intermediate Activity (SIMA) complex. The building was constructed in 1958 and renovated in 1985. Structures associated with NS-26 include several storage sheds and steel storage trailers. In December 1996, a 200-gallon UST which contained waste oil was removed.

Three dip tanks were located in the west end of the facility and were used to clean ship parts. The contents of the tanks were tri-sodium phosphate, citric acid, and water. The tanks were cleaned bi-annually by CNC personnel.

An initial assessment study in 1981 noted that the following hazardous wastes were generated at this facility: boiler cleaning solution (sulfuric acid and nitric acid); cleaning solvents (chlorinated hydrocarbons); and boiler test chemicals (mercuric nitrate). From 1958 through 1981, disposal practices reportedly included discharging neutralized boiler solutions, solvents, and mercuric nitrate solutions directly into the Cooper River.

Historic information indicates that the area was used as a seaplane refueling ramp and as an oil storage area in the 1940s.

AOC 680 also includes the former grinding room in Building NS-26, reportedly used to repair brake components containing asbestos. Building plans from 1969 show the grinding room on the southern side of Building NS-26. Reportedly, brake repair ceased in 1970. The area once occupied by the grinding room was remodeled in 1985 and is now a short hallway to the southern entrance to the building.

Soil was sampled in two rounds at AOC 680 from the locations shown on Figure 10.5.1. The Final RFI work plan proposed collecting one geoprobe soil sample, and four soil samples from the upper- interval and four from the lower- interval. Four proposed upper- interval samples and three of the four proposed lower- interval soil samples were collected. One lower-interval sample was not collected because the water table was encountered at less than 5 bgs. All samples were submitted for analysis at DQO Level III for VOCs, SVOCs, and metals. Two samples selected as duplicates were analyzed at DQO Level IV for Appendix IX analytical parameters, which includes a more comprehensive list of VOCs and SVOCs. All samples from round two were submitted for the standard suite of parameters which include VOCs, SVOCs, pesticides, PCBs, cyanide, and metals.

To characterize the zone groundwater, three shallow monitoring wells were installed and sampled in accordance with an approved final RFI work plan. Three rounds of groundwater sampling were completed at AOC 680. During the first and third rounds of sampling, AOC 680 was sampled for VOCs and SVOCs at DQO Level III. Samples from round two were also sampled for metals.

10.5.8.2 COPC Identification

Surface Soil

Based on the screening comparisons described in Section 7 of this RFI and presented in Table 10.5.13, the focus of this HHRA is on benzo(a)pyrene equivalents. Aluminum, arsenic and chromium were detected at maximum concentrations exceeding their RBCs but not exceeding their respective background concentrations. Therefore, these inorganics were eliminated from further consideration in the AOC 680 HHRA. The results of Wilcoxon rank sum test analyses did not

Table 10.5.13
Chemicals Present in Site Sample
AOC 680 - Surface Soil
Charleston Naval Complex
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration Residential RBC	Reference	Units	Number Exceeding RBC	Reference
Carcinogenic PAHs													
Benzo(a)pyrene Equivalents	*	2	6	1.625	260.37	131	448	497	87	NA	µg/kg	1	
Benzo(a)anthracene		2	6	16	270	143	370	410	870	NA	µg/kg		
Benzo(a)pyrene	*	1	6	210	210	210	370	410	87	NA	µg/kg	1	
Benzo(b)fluoranthene		1	6	210	210	210	370	410	870	NA	µg/kg		
Benzo(k)fluoranthene		1	6	210	210	210	370	410	8700	NA	µg/kg		
Chrysene		2	6	25	270	147.5	370	410	87000	NA	µg/kg		
Inorganics													
Aluminum (Al)		1	1	8680	8680	8680	NA	NA	7800	27400	mg/kg	1	
Arsenic (As)		1	1	3.6	3.6	3.6	NA	NA	0.43	21.6	mg/kg	1	
Barium (Ba)		1	1	19.2	19.2	19.2	NA	NA	550	54.2	mg/kg		
Beryllium (Be)		1	1	0.34	0.34	0.34	NA	NA	16	0.95	mg/kg		
Cadmium (Cd)		1	1	0.45	0.45	0.45	NA	NA	7.8	0.61	mg/kg		
Calcium (Ca)	N	1	1	55600	55600	55600	NA	NA	NA	NA	mg/kg		
Chromium (Cr)		1	1	24.5	24.5	24.5	NA	NA	23	34.5	mg/kg	1	
Cobalt (Co)		1	1	1.5	1.5	1.5	NA	NA	470	5.8	mg/kg		
Copper (Cu)		1	1	5.9	5.9	5.9	NA	NA	310	240	mg/kg		
Iron (Fe)	N	1	1	6190	6190	6190	NA	NA	NA	NA	mg/kg		
Lead (Pb)		1	1	10.7	10.7	10.7	NA	NA	400	203	mg/kg		
Magnesium (Mg)	N	1	1	2070	2070	2070	NA	NA	NA	NA	mg/kg		
Manganese (Mn)		1	1	46.7	46.7	46.7	NA	NA	1100	419	mg/kg		
Mercury (Hg)		1	1	0.05	0.05	0.05	NA	NA	2.3	0.47	mg/kg		
Nickel (Ni)		1	1	8.5	8.5	8.5	NA	NA	160	23.9	mg/kg		
Potassium (K)	N	1	1	626	626	626	NA	NA	NA	NA	mg/kg		
Selenium (Se)		1	1	0.29	0.29	0.29	NA	NA	39	1.49	mg/kg		
Sodium (Na)	N	1	1	318	318	318	NA	NA	NA	NA	mg/kg		
Vanadium (V)		1	1	19	19	19	NA	NA	55	113	mg/kg		
Zinc (Zn)		1	1	35.4	35.4	35.4	NA	NA	2300	206	mg/kg		
Semivolatile Organics													
Butylbenzylphthalate		1	6	430	430	430	370	410	1600000	NA	µg/kg		
bis(2-Ethylhexyl)phthalate		2	6	22	310	166	370	380	46000	NA	µg/kg		
Fluoranthene		1	6	340	340	340	370	410	310000	NA	µg/kg		
Phenanthrene		1	6	28	28	28	370	400	310000	NA	µg/kg		
Pyrene		2	6	16	440	228	370	410	230000	NA	µg/kg		
Volatile Organics													
Acetone		1	6	77	77	77	23	58	780000	NA	µg/kg		
1,1-Dichloroethane		1	6	6	6	6	5.6	6.2	780000	NA	µg/kg		
1,2-Dichloroethene (total)		1	6	41	41	41	5.6	6.2	70000	NA	µg/kg		
Ethylbenzene		2	6	0.96	2.2	1.58	5.7	29	780000	NA	µg/kg		
4-Methyl-2-Pentanone		1	6	3	3	3	28	31	630000	NA	µg/kg		
Tetrachloroethene		1	6	420	420	420	5.6	6.2	12000	NA	µg/kg		
Toluene		1	6	1.6	1.6	1.6	5.6	14	1600000	NA	µg/kg		
Trichloroethene		1	6	140	140	140	5.6	6.2	58000	NA	µg/kg		
Xylene (Total)		4	6	1.5	10	4.1	5.8	6.2	16000000	NA	µg/kg		

Notes:
* - Indicates chemical was identified as a COPC
N - Indicates chemical is an essential nutrient
SQL - Sample quanititation limit
RBC - Risk based concentration
µg/kg - micrograms per kilogram
mg/kg - milligrams per kilogram
NA - Not applicable or not available

result in the inclusion of any inorganic parameters which screened out on the basis of background concentration comparisons.

Groundwater

As shown in Table 10.5.14, the following chemicals were identified as COPCs in shallow groundwater at SWMU 12: acetone, arsenic, benzene, 2-butanone, bis(2-ethylhexyl)phthalate, tetrachloroethene, and trichloroethene. Acetone, benzene, 2-butanone, and bis(2-ethylhexyl)phthalate were only reported in a single sample each (680GP00501 reported detectable concentrations of acetone, 2-butanone, and bis(2-ethylhexyl)phthalate and 680GP00502 reported a detection of benzene). Geoprobe location 680GP005 was positioned to investigate potential releases from an oil-water separator. Monitoring well 680004 was also installed in the vicinity of the oil-water separator and associated waste oil UST. These were not detected in levels of organic in the sample collected from well 680004. The data from the geoprobe samples were not used in the quantitative risk assessment since none of these COPCs (acetone, benzene, 2-butanone, and bis(2-ethylhexyl)phthalate) were reported in samples collected from monitoring well 680004.

10.5.8.3 Exposure Assessment

Exposure Setting

AOC 680 is the former grinding room in Building NS-26 located in the northeast corner of Zone I along the Cooper River. Current exposures to soil and groundwater at this site are limited due to pavement covering of the soil and the readily available municipal water supply which alleviates the need to use groundwater as a source of potable or process water.

Table 10.5.14
Chemicals Present in Site Sample
AOC 680 - Groundwater
Charleston Naval Complex
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration Residential RBC	Screening Concentration Reference	Units	Number Exceeding RBC	Number Exceeding Reference
Inorganics													
Arsenic (As)	*	2	3	3.1	51.8	27.45	0.9	0.9	0.045	23	µg/L	2	1
Calcium (Ca)	N	3	3	64600	119000	97200	NA	NA	NA	NA	µg/L		
Chromium (Cr)		1	3	8.2	8.2	8.2	6.4	6.4	11	14.3	µg/L		
Iron (Fe)	N	1	3	3340	3340	3340	106	125	NA	NA	µg/L		
Magnesium (Mg)	N	3	3	18900	53700	38833	NA	NA	NA	NA	µg/L		
Manganese (Mn)		3	3	20.5	82.3	55.2	NA	NA	73	5430	µg/L		
Potassium (K)	N	3	3	12300	40700	29400	NA	NA	NA	NA	µg/L		
Sodium (Na)	N	2	3	412000	446000	429000	67100	67100	NA	NA	µg/L		
Semivolatile Organics													
bis(2-Ethylhexyl)phthalate	*	1	8	38	38	38	6	10	4.8	NA	µg/L	1	
Naphthalene		1	8	9.5	9.5	9.5	6	100	73	NA	µg/L		
Volatile Organics													
Acetone	*	1	6	3800	3800	3800	5	10	370	NA	µg/L	1	
Benzene	*	1	10	0.62	0.62	0.62	1	5	0.36	NA	µg/L	1	
2-Butanone (MEK)	*	1	10	310	310	310	5	10	190	NA	µg/L	1	
Carbon disulfide		3	10	0.26	4.8	1.89	1	5	100	NA	µg/L		
Chlorobenzene		1	10	1.7	1.7	1.7	1	5	3.5	NA	µg/L		
1,1-Dichloroethane		2	10	0.89	1	0.945	1	5	80	NA	µg/L		
1,2-Dichlorobenzene		1	8	1	1	1	6	100	6.4	NA	µg/L		
1,2-Dichloroethene (total)		5	9	0.63	3	1.386	1	5	5.5	NA	µg/L		
Tetrachloroethene	*	3	10	0.64	2	1.3	1	5	1.1	NA	µg/L	2	
Trichloroethene	*	2	10	0.85	3	1.925	1	5	1.6	NA	µg/L	1	

Notes:
* - Indicates chemical was identified as a COPC
N - Indicates chemical is an essential nutrient
SQL - Sample quantitation limit
RBC - Risk based concentration
µg/L - micrograms per liter
NA - Not available or not applicable

Potentially Exposed Populations

Potentially exposed populations are current and future site workers and hypothetical future site residents. Future site resident and worker exposure scenarios were addressed quantitatively in this risk assessment. Current exposure to workers is discussed quantitatively in relation to the future workers and future residents. The hypothetical future site worker scenario assumed continuous exposure to surface soil conditions and the use of groundwater as a potable water source. Current site workers' exposure would be less than that assumed for the hypothetical future site worker scenario because of their limited soil contact and the fact that groundwater is not currently used onsite. Therefore, future worker assessment is considered to be conservatively representative of current site workers. The future site resident scenario was built on the premise that existing features would be removed and replaced with dwellings. Groundwater exposure pathways would not be completed if the municipal water supply is kept in place. As a highly conservative estimate of potential risk due to groundwater pathways, a residential scenario and a site worker scenario were considered for AOC 680 groundwater.

Exposure Pathways

Exposure pathways for the site workers are dermal contact and incidental ingestion of COPCs in surface soils, and ingestion and inhalation of contaminants reported in groundwater through domestic and process uses. The exposure pathways for future site residents are the same as those for the future site worker. In addition, the hypothetical future site worker scenario assumed continuous exposure to surface soil and groundwater conditions. Uniform exposure was assumed for all sample locations. Table 10.5.15 presents the justification for exposure pathways assessed in this HHRA.

Table 10.5.15
AOC 680
Exposure Pathways Summary

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Current Land Uses			
Current Users (Site Workers)	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	This exposure pathway was considered insignificant compared to the other pathways.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Shallow groundwater is not currently used as a source of potable or non-residential water at AOC 680.
	Shallow groundwater, Inhalation of volatilized shallow groundwater contaminants	No	Shallow groundwater is not currently used as a source of potable or non-residential water at AOC 680.
	Soil, Incidental ingestion	No (Qualified)	Future site use is considered conservatively representative of current site use.
	Soil, Dermal contact	No (Qualified)	Future site use is considered conservatively representative of current site use.
Future Land Uses			
Future Site Residents (Child and Adult), Future Site Worker	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	This exposure pathway was considered insignificant compared to the other pathways.
	Shallow groundwater, ingestion of contaminants during potable or general use	Yes	Shallow groundwater is not likely to be used as a source of potable or process water at AOC 680. This pathway was addressed as a conservative measure.
Future Site Residents (Child and Adult), Future Site Worker (Continued)	Shallow groundwater, Inhalation of volatilized contaminants during domestic use	Yes	Shallow groundwater is not likely to be used as a source of potable or process water at AOC 680. This pathway was addressed as a conservative measure.
	Soil, Incidental ingestion	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.
	Soil, Dermal contact	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.
	Wild game or domestic animals, Ingestion of tissue impacted by media contamination	No	Hunting/taking of game and/or raising livestock is prohibited within the Charleston, South Carolina city limits.
	Fruits and vegetables, Ingestion of plant tissues grown in media	No	The potential for significant exposure via this pathway is low relative to that of other exposure pathways assessed.

Exposure Point Concentrations

As discussed in Section 7 of this RFI, UCLs are generally calculated for datasets consisting of at least ten samples. Since only six surface soil samples were collected for AOC 680, the maximum reported concentration of benzo(a)pyrene equivalents was used as its EPC.

Table 10.5.16 summarizes the determination of the groundwater EPC. Four monitoring wells were installed at AOC 680. Current EPA guidance favors the arithmetic mean in the most concentrated area of the plume as the EPC for groundwater COPCs. Groundwater COPCs cannot be associated with a single distinct plume at AOC 680. Instead each of the COPCs were assigned to their own "plume". In each case, a separate plume is defined by the monitoring well which produced the highest concentration for a given COPC. For example, the maximum tetrachloroethene detection (0.002 mg/L) was from monitoring well 680002 sampled during the second round. The first round sample from this monitoring well reported tetrachloroethene at a concentration of 0.0014 mg/L. The data from the two rounds yield an average of 0.0017 mg/L. As explained in Section 7 another method for calculating EPCs compares the maximum detected concentration with the 95% UCL. The 95% UCL is selected as the EPC unless it exceeds the maximum detected concentration, in which case the maximum detected concentration is selected as the EPC. In determining the EPC for AOC 680 groundwater COPCs, the method (mean in plume or 95% UCL/maximum concentration) which produced the higher EPC was selected.

Quantification of Exposure

Soil

CDIs for ingestion and dermal contact with soils are shown in Tables 10.5.17 and 10.5.18, respectively.

Groundwater

CDIs for each shallow groundwater COPC are presented in Table 10.5.19.

Table 10.5.16
Statistical Analysis of COPCs in Groundwater
AOC 680
Charleston Naval Complex
Charleston, South Carolina

COPC	n	Natural Log Transformed mean	SD	H-stat	Mean in Plume (mg/L	UCL (mg/L)	MAX (mg/L)	EPC (mg/L)	
Inorganics									
Arsenic	3	NA	NA	NA	NA	NA	0.0518	0.0518	MAX
Volatile Organics									
Tetrachloroethene	10	-6.793	0.676	2.493	0.0017	0.0025	0.002	0.0020	MAX
Trichloroethene	10	-6.827	0.753	2.626	0.0019	0.0028	0.003	0.0028	UCL

NOTES:

mean	arithmetic mean of the logtransformed data
n	number of samples analyzed
SD	standard deviation for a sample of data
H-stat	"H" statistic from Gilbert 1987; cuboidal interpolation was used to determine the value in accordance with USEPA Supplemental Guidance to RAGS, Calculating the Concentration Term
NA	not applicable
ND	not determined
TEF	toxic equivalency factor
EPC	exposure point concentration
UCL	95 percentile upper confidence level mean
MAX	maximum reported concentration

Table 10.5.17
Chronic Daily Intakes (CDI)
Incidental Ingestion of Surface Soil
AOC 680
Charleston Naval Complex
Charleston, South Carolina

Chemical	Fraction Ingested from Contaminated Source*	Exposure Point Concentration (mg/kg)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident LWA C-CDI (mg/kg-day)	Future Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Benzo(a)pyrene Equivalent	1	0.23	3.16E-07	2.95E-06	3.61E-07	1.13E-07	4.03E-08

NOTES:

TEF toxic equivalency factor relative to Benzo(a)pyrene
LWA lifetime weighted average; used to calculate carcinogenic CDI, RAGS Parts A and B
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
* Reflects the estimated fraction of the site impacted by the corresponding COPC.

Table 10.5.18
Chronic Daily Intakes (CDI)
Dermal Contact with Surface Soil
AOC 680
Charleston Naval Complex
Charleston, South Carolina

Chemical	Exposure Point Concentration (mg/kg)	Fraction Contacted from Contaminated Source *	Dermal Absorption Factor (unitless)+	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident LWA C-CDI (mg/kg-day)	Future Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Benzo(a)pyrene Equivalents	0.23	1	0.01	1.29E-07	4.27E-07	8.10E-08	9.24E-08	3.30E-08

NOTES:

TEF Toxic Equivalency Factor relative to Benzo(a)pyrene
CDI Chronic Daily Intake in mg/kg-day
LWA Lifetime weighted average
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
\+ The dermal absorption factor was applied to the exposure point concentration to reflect the different trans-dermal migration of inorganic versus organic chemicals
* Reflects the estimated fraction of the site impacted by the corresponding COPC.

Table 10.5.19
Chronic Daily Intakes (CDI)
Ingestion/Inhalation of COPCs in Groundwater
AOC 680
Charleston Naval Complex
Charleston, South Carolina

Chemical	Exposure Point Concentration (mg/liter)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident LWA C-CDI (mg/kg-day)	Future Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Inorganics						
Arsenic	0.0518	1.42E-03	3.31E-03	7.81E-04	5.07E-04	1.81E-04
Volatiles						
Tetrachloroethene	0.0020	5.48E-05	1.28E-04	3.01E-05	1.96E-05	6.99E-06
Trichloroethene	0.0028	7.62E-05	1.78E-04	4.19E-05	2.72E-05	9.72E-06

NOTES:
LWA lifetime weighted average
CDI Chronic Daily Intake
H-CDI Non-carcinogenic hazard based Chronic Daily Intake
C-CDI Carcinogenic risk based Chronic Daily Intake

10.5.8.4 Toxicity Assessment

Toxicity assessment terms and methods are discussed in Section 7 of this report. Table 10.5.20 presented toxicological information specific to each COPC identified at AOC 680. This information was used in the quantification of risk potentially associated with soil and groundwater contaminants. Brief toxicological profiles for each COPC are provided in the following paragraphs.

Arsenic exposure via the ingestion route causes darkening and hardening of the skin in chronically exposed humans. Inhalation exposure to arsenic causes neurological deficits, anemia, and cardiovascular effects (Klaasen, et al., 1986). Arsenic's effects on the nervous and cardiovascular systems are primarily associated with acute exposure to higher levels. USEPA set 0.3 μg/kg-day as the oral RfD for arsenic based on a NOAEL of 0.8 μg/kg-day in a human exposure study. As listed in IRIS the critical effect of this chemical is hyperpigmentation, keratosis, and possible vascular complications. The uncertainty factor was determined to be 3 and the modifying factor was determined to be 1. Exposure to arsenic-containing materials has been shown to cause cancer in humans. Inhalation of these materials can lead to increased lung cancer risk, and ingestion of these materials is associated with increased skin cancer rates. Arsenic has been classified as a group A carcinogen by USEPA with an oral SF of 1.5 $(mg/kg\text{-}day)^{-1}$. As listed in IRIS the basis for the classification is sufficient evidence from human data. An increased lung cancer mortality was observed in multiple human populations exposed primarily through inhalation. Also, increased mortality from multiple internal organ cancers (liver, kidney, lung, and bladder) and an increased incidence of skin cancer were observed in populations consuming drinking water high in inorganic arsenic.

Table 10.5.20
Toxicological Reference Information
for Chemicals of Potential Concern
AOC 680
Charleston Naval Complex
Charleston, South Carolina

	Non-Carcinogenic Toxicity Data								*Carcinogenic Toxicity Data*			
Chemical	Oral Reference Dose (mg/kg-day)	Confidence Level	Critical Effect	Uncertainty Factor Oral	Inhalation Reference Dose (mg/kg-day)	Confidence Level	Critical Effect	Uncertainty Factor Inhalation	Oral Slope Factor (kg-day/mg)	Inhalation Slope Factor (kg-day/mg)	Weight of Evidence	Tumor Type
Arsenic	0.0003 a	M	hyperpigmentation	3	NA	NA	NA	NA	1.5 a	15.1 a	A	various
Benzo(a)pyrene equivalents	NA	NA	NA	NA	NA	NA	NA	NA	7.3 a	3.1 b	B2	mutagen
Tetrachloroethene	0.01 a	M	Hepatotoxicity	1000	0.14 b	NA	NA	NA	0.052 b	0.002 b	NA	NA
Trichloroethene	0.006 b	NA	NA	NA	NA	NA	NA	NA	0.011 b	0.006 b	NA	NA

Notes:

a = Integrated Risk Information System (IRIS)
b = EPA NCEA - Cincinnati (provisional)
NA = Not applicable or not available
H = High confidence
L = Low confidence
M = Medium confidence

Benzo(a)pyrene equivalents include the following list of polynuclear aromatic hydrocarbons (PAHs):

Benzo(a)anthracene	TEF 0.1
Benzo(b)fluoranthene	TEF 0.1
Dibenz(a,h)anthracene	TEF 1.0
Benzo(k)fluoranthene	TEF 0.01
Benzo(a)pyrene	TEF 1.0
Indeno(1,2,3-cd)pyrene	TEF 0.1
Chrysene	TEF 0.001

Some PAHs are toxic to the liver, kidney, and blood. However, the toxic effects of the PAHs above have not been well established. There are no RfDs for the PAHs above due to a lack of data. All PAHs listed above are classified by USEPA as B2 carcinogens, and their carcinogenicity is addressed relative to that of benzo(a)pyrene, having an oral SF of 7.3 $(mg/kg\text{-}day)^{-1}$. Toxicity Equivalency Factors (TEFs), also set by USEPA, are multipliers that are applied to the detected concentrations, which are subsequently used to calculate excess cancer risk. Most carcinogenic PAHs have been classified as such due to animal studies using large doses of purified PAHs. There is some doubt as to the validity of these listings, and the SFs listed in USEPA's RBC table are provisional. However, these PAHs are carcinogens when the exposure involves a mixture of other carcinogenic substances (e.g., coal tar, soot, cigarette smoke, etc.). As listed in IRIS, the basis for the benzo(a)pyrene B2 classification is animal studies. Human data specifically linking benzo(a)pyrene to a carcinogenic effect are lacking. There are, however, multiple animal studies in many species demonstrating benzo(a)pyrene to be carcinogenic by numerous routes.

Tetrachloroethene (PCE) has been used as a solvent in industry and occurs as a volatile constituent in other chlorinated hydrocarbons. Tetrachloroethene exposure can result in long-lasting narcosis with delayed onset and damage to the liver and kidneys. The principal manifestations of overexposure to this halogenated hydrocarbon are coma, jaundice, oliguria, and irritation of the eyes and nose followed by headache and nausea. PCE exposure via the inhalation and/or skin absorption exposure pathways could result in headache, tremor, dizziness, peripheral paresthesia, hypesthesia or anesthesia. PCE is a carcinogen, but is currently under review by USEPA; it is currently classified as a B2-C carcinogen. The oral RfD has been set to 0.01 mg/kg-day, and the oral SF and inhalation SF have been set to 0.052 and 0.0023 $(mg/kg\text{-}day)^{-1}$, respectively, by USEPA (Dreisbach et al., 1987).

Trichloroethene (TCE) is a mobile, volatile liquid which has the characteristic odor of chloroform. Inhalation, intravenous, and subcutaneous routes are all viable exposure pathways for this compound. TCE is a strong skin and eye irritant that is relatively less toxic if ingested. Inhaling high concentrations causes narcosis and anesthesia. This compound targets the liver and other organs. TCE is a B2 carcinogen, and the oral SF and inhalation SF have been set by USEPA to 0.011 and 0.006 $(mg/kg\text{-}day)^{-1}$, respectively. USEPA also set the oral RfD to 0.006 mg/kg-day (Dreisbach et al., 1987).

10.5.8.5 Risk Characterization

Surface Soil Pathways

Exposure to surface soil onsite was evaluated under both residential and future site worker scenarios. For these scenarios, the incidental ingestion and dermal contact exposure pathways were evaluated. Tables 10.5.21 and 10.5.22 present the computed carcinogenic risks associated with the incidental ingestion of and dermal contact with site surface soils, respectively.

Table 10.5.21
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
AOC 680
Charleston Naval Complex
Charleston, South Carolina

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used $(mg/kg\text{-}day)^{-1}$	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident LWA ILCR	Future Worker adult Hazard Quotient	Future Worker adult ILCR
Benzo(a)pyrene Equivalents	NA	7.3	ND	ND	2.6E-06	ND	2.9E-07
SUM Hazard Index/ILCR			ND	ND	3E-06	ND	3E-07

NOTES:

NA Not available
ND Not Determined due to lack of available information
LWA lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

Table 10.5.22
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
AOC 680
Charleston Naval Complex
Charleston, South Carolina

Chemical	Dermal Adjustment+	Oral RfD Used (mg/kg-day)	Oral SF Used $(mg/kg\text{-}day)^{-1}$	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident LWA ILCR	Future Worker adult Hazard Quotient	Future Worker adult ILCR
Benzo(a)pyrene Equivalents	0.5	NA	14.6	ND	ND	1.2E-06	ND	4.8E-07
SUM Hazard Index/ILCR				ND	ND	1E-06	ND	5E-07

NOTES:

NA Not available
ND Not Determined due to lack of available information
LWA lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk
+ Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)

Hypothetical Site Residents

The ingestion ILCR (based on the adult and child lifetime weighted average) for AOC 680 surface soils is 3E-06. The dermal pathway ILCR is 1E-06. Benzo(a)pyrene equivalents were the sole contributor for each pathway.

Hypothetical Future Site Workers

Site worker ILCRs are 3E-07 and 5E-07 for the ingestion and dermal contact pathways, respectively. Benzo(a)pyrene equivalents were the sole contributor for each pathway.

Groundwater Pathways

Exposure to groundwater onsite was evaluated under both residential and site worker scenarios. The ingestion and inhalation exposure pathways were evaluated assuming the site groundwater will be used for potable and/or domestic purposes and that an unfiltered well drawing from the corresponding water bearing zone, will be installed. For non-carcinogenic contaminants evaluated relative to future site residents, hazard index was computed separately for child and adult receptors. Tables 10.5.23 and 10.5.24 present the estimated risk and hazard for the ingestion and inhalation exposure pathways, respectively.

Hypothetical Site Residents

The sum ILCR for the groundwater ingestion pathway was computed as 1E-03. Arsenic was the primary contributor to risk estimates based on the ingestion pathway. The hazard indices for the adult and child resident ingestion pathway are 5 and 11, respectively. Arsenic was the primary contributor to the ingestion pathway hazard index. The ILCR for the inhalation pathway was computed to be 3E-07. The hazard index for the inhalation pathway was computed to be 0.0004 and 0.0009 for the adult and child receptors, respectively.

Table 10.5.23
Hazard Quotients and Incremental Lifetime Cancer Risks
Shallow Groundwater Ingestion
AOC 680
Charleston Naval Complex
Charleston, South Carolina

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used $(mg/kg\text{-}day)^{-1}$	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident LWA ILCR	Future Worker adult Hazard Quotient	Future Worker adult ILCR
Inorganics							
Arsenic	3E-04	1.5	4.7	11	1.2E-03	1.7	2.7E-04
Volatile Organics							
Tetrachloroethene	0.01	0.052	0.0055	0.013	1.6E-06	0.0020	3.6E-07
Trichloroethene	0.006	0.011	0.0127	0.030	4.6E-07	0.0045	1.1E-07
SUM Hazard Index/ILCR			5	11	1E-03	2	3E-04

NOTES:
NA Not available
ND Not Determined due to lack of available information
LWA lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

Table 10.5.24
Hazard Quotients and Incremental Lifetime Cancer Risks
Inhalation of COPCs in Groundwater
AOC 680
Charleston Naval Complex
Charleston, South Carolina

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used $(mg/kg\text{-}day)^{-1}$	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident LWA ILCR	Future Worker adult Hazard Quotient	Future Worker adult ILCR
Volatile Organics							
Tetrachloroethene	0.14	0.002	0.00039	0.00091	6.0E-08	0.00014	1.4E-08
Trichloroethene	NA	0.006	ND	ND	2.5E-07	ND	5.8E-08
SUM Hazard Index/ILCR			0.0004	0.0009	3E-07	0.0001	7E-08

NOTES:

NA Not available
ND Not Determined due to lack of available information
LWA lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

Hypothetical Future Site Workers

The sum ILCR for the groundwater ingestion pathway was computed to be 3E-04. Arsenic was the primary contributor to risk estimates based on the ingestion pathway. The hazard indices for the site worker ingestion pathway is 2. Arsenic was the primary contributor to the ingestion pathway hazard index. The ILCR for the inhalation pathway was computed to be 7E-08. The hazard index for the inhalation pathway was computed to be 0.0001.

Current Site Workers

Groundwater is not currently used as a potable water source for AOC 680 or other areas of Zone I. In the absence of a completed exposure pathway, no threat to human health is posed by reported groundwater contamination.

COCs Identified

USEPA has established a generally acceptable risk range of 1E-04 to 1E-06, and a hazard index threshold of 1 (unity). As recommended by SCDHEC, a COC was considered to be any chemical contributing to a cumulative cancer risk level of 1E-06 or greater and/or a cumulative hazard index above 1, and whose individual ILCR exceeds 1E-06 or whose hazard quotient exceeds 0.1. For carcinogens, this approach is relatively conservative, because a cumulative risk level of 1E-04 (and individual ILCR of 1E-06) is recommended by USEPA Region IV as the trigger for establishing COCs. The COC selection method presented was used in order to provide a more comprehensive evaluation of chemicals contributing to carcinogenic risk or non-carcinogenic hazard during the remedial goal options development process. Table 10.5.25 presents the COCs identified for AOC 680 surface soil and groundwater.

Table 10.5.25
Summary of Risk and Hazard-based COCs for AOC 680
Charleston Naval Complex
Charleston, South Carolina

Medium	Exposure Pathway		Future Resident Adult Hazard Quotient	Future Resident Child Hazard Quotient	Future Resident LWA ILCR	Future Site Worker Hazard Quotient	Future Site Worker ILCR	Identification of COCs
Surface Soil	Incidental Ingestion	Benzo(a)pyrene Equivalents	ND	ND	2.6E-06	ND	2.9E-07	2
	Dermal Contact	Benzo(a)pyrene Equivalents	ND	ND	1.2E-06	ND	4.8E-07	2
Surface Soil Pathway Sum			ND	ND	4E-06	ND	8E-07	
Groundwater	Ingestion	Inorganics						
		Arsenic	5	11	1.2E-03	1.7	2.7E-04	1 2 3 4
		Volatile Organics						
		Tetrachloroethene	0.0055	0.013	1.6E-06	0.0020	3.6E-07	2
		Trichloroethene	0.0127	0.030	4.6E-07	0.0045	1.1E-07	
	Inhalation	Volatile Organics						
		Tetrachloroethene	0.00039	0.00091	6.0E-08	0.00014	1.4E-08	
		Trichloroethene	ND	ND	2.5E-07	ND	5.8E-08	
Groundwater Pathway Sum			5	11	1E-03	2	3E-04	
Sum of All Pathways			5	11	1E-03	2	3E-04	

Notes:
ND indicates not determined due to the lack of available risk information.
ILCR indicates incremental excess lifetime cancer risk
HI indicates hazard index
LWA Lifetime weighted average
1- Chemical is a COC by virtue of projected child residence non-carcinogenic hazard.
2- Chemical is a COC by virtue of projected future resident lifetime ILCR.
3- Chemical is a COC by virtue of projected site worker non-carcinogenic hazard.
4- Chemical is a COC by virtue of projected site worker ILCR.

Surface Soils

Hypothetical Site Residents

Benzo(a)pyrene equivalents were identified as COCs for this scenario based on their contribution to ILCR.

Hypothetical Future Site Workers

No COCs were identified for this scenario.

Groundwater

Hypothetical Site Residents

Arsenic and tetrachloroethene were identified as groundwater COCs based upon their contribution to ILCR. Arsenic was identified as a COC based its contribution to hazard index.

Hypothetical Future Site Workers

Arsenic was identified as groundwater a COC based upon its contribution to ILCR and hazard index.

10.5.8.6 Risk Uncertainty

Characterization of Exposure Setting and Identification of Exposure Pathways

The potential for high bias is introduced through the exposure setting and pathway selection due to the highly conservative assumptions (i.e., future residential use) recommended by USEPA Region IV when assessing potential future and current exposure. The exposure assumptions made in the site worker scenario are highly conservative and would tend to overestimate exposure. Current site workers are not exposed to site groundwater.

Residential use of the site would not be expected, based on current site uses and the surrounding buildings. Current reuse plans call for continued non-residential use of Zone I. If this area were to be used as a residential site, the regrading for development would likely change existing conditions. Surface soil could be covered with landscaping soil, a driveway and/or a house. Consequently, exposure to current surface soil conditions would not be likely under a true future residential scenario. These factors indicate that exposure pathways assessed in this HHRA would generally overestimate the risk posed to current site workers and future site residents.

Groundwater is not currently used at AOC 680 for potable or industrial purposes. A basewide system provides drinking and process water to buildings throughout Zone I. This system is slated to remain in operation under the current base reuse plan. As a result, groundwater use would not be expected under future site use scenarios. Therefore, the screening scenario established for this site associated with groundwater exposure is highly conservative, and associated pathways are not expected to be completed in the future.

Determination of Exposure Point Concentrations

The maximum concentration of benzo(a)pyrene equivalents was applied as the EPC to evaluate the soil pathways. This represents a upper bound estimate that is likely to result in an overestimation of risk.

Two methods were used to calculated EPCs for estimating groundwater pathway risk. The first method is based on EPA Region 4 guidance which states that the average concentration of each COPC in the most concentrated area of the plume should be used as the EPC. Since a plume cannot be readily defined, this guidance applies only marginally. The second method involved the calculation of 95% UCLs which were compared to maximum concentrations. As described in Section7, if 95% UCLs exceeded maximum concentrations then maximum concentration would be selected as the EPC. Otherwise the 95% UCL was selected. For each groundwater COPC, the EPC was determined using the method that produced the highest representative concentration. The method used to determine groundwater EPCs likely resulted in an overestimation of risk.

Frequency of Detection and Spatial Distribution

Surface Soil

Benzo(a)pyrene equivalents were detected in two of six surface soil samples and was only reported in one sample at a concentration above its RBC. As a result, future site uses will likely result in only isolated instances of exposure to elevated levels of benzo(a)pyrene equivalents as opposed to the consistent exposure assumed in this risk assessment.

Groundwater

Out of three groundwater samples collected, arsenic was reported at concentrations above its tap water RBC in two groundwater samples and at concentrations above its MCL in only one sample. Only one sampling event was conducted for arsenic which introduces uncertainty with respect to potential temporal changes in arsenic concentration in the AOC 680 groundwater. Tetrachloroethene was reported in both groundwater samples collected from monitoring well 680002 at concentrations above its tap water RBC.

Quantification of Risk/Hazard

As indicated by the discussions above, the uncertainty inherent in the risk assessment process is great. In addition, many site-specific factors have affected the uncertainty of this assessment that would upwardly bias the risk estimates. Exposure pathway-specific sources of uncertainty are discussed below.

Soil

Of the CPSSs screened from formal assessment, none eliminated were reported at concentrations close to the corresponding RBCs (i.e., within approximately ten percent of the RBC). This minimizes the likelihood of potentially significant cumulative risk/hazard with respect to the eliminated CPSSs. Aluminum, arsenic, and chromium exceeded their corresponding RBCs, but these elements did not exceed the corresponding background concentrations. Therefore, they were eliminated from formal assessment based on comparisons to corresponding background concentrations.

Groundwater

Of the CPSSs screened and eliminated from formal assessment, none were reported at a concentration close to their RBC. This minimizes the likelihood of potentially significant cumulative risk/hazard based on the eliminated CPSSs.

Groundwater is not currently used as a potable water source at AOC 680, nor is it used in the surrounding area. Municipal water is readily available. As previously mentioned, it is highly unlikely that the site will be developed as a residential area, and it is unlikely that a potable-use well would be installed onsite. It is probable that, if residences were constructed onsite and an unfiltered well were installed, the salinity and dissolved solids would preclude this aquifer from being an acceptable potable water source.

10.5.8.7 Risk Summary

The risk posed by contaminants at AOC 680 were assessed for the site worker and the hypothetical future site resident under reasonable maximum exposure assumptions. In surface soils, the incidental ingestion and dermal contact pathways were assessed in this HHRA. Ingestion and inhalation were evaluated for groundwater based on all available rounds of groundwater monitoring data. Table 10.5.26 presents the risk summary for each pathway/receptor group evaluated for AOC 680.

Table 10.5.26
Summary of Risk and Hazard for AOC 680
Charleston Naval Complex
Charleston, South Carolina

Medium	Exposure Pathway	HI (Adult)	HI (Child)	ILCR (LWA)	HI (Worker)	ILCR (Worker)
Surface Soil	Incidental Ingestion	ND	ND	3E-06	ND	3E-07
	Dermal Contact	ND	ND	1E-06	ND	5E-07
Shallow Groundwater	Ingestion	5	11	1E-03	2	3E-04
	Inhalation	0.0004	0.0009	3E-07	0.0001	7E-08
Sum of All Pathways		5	11	1E-03	2	3E-04

Notes:
ND indicates not determined due to the lack of available risk information.
ILCR indicates incremental excess lifetime cancer risk
HI indicates hazard index
LWA Lifetime weighted average

Soil — Future Residential Scenario

Benzo(a)pyrene equivalents were identified as residential soil pathway COCs for AOC 680. Figure 10.5.8 provides the risk map for AOC 680 soil. As shown only one sample location was associated with a risk above 1E-06 (680SB003). Table 10.5.27 provides the point risk estimates for AOC 680 soil pathways.

Soil — Future Site Worker Scenario

No industrial soil pathway COCs were identified for AOC 680.

Groundwater — Future Residential Scenario

Arsenic and tetrachloroethene were identified as groundwater pathway COCs. Table 10.5.28 provides details of risk estimates for the groundwater pathways and covers all rounds of data. As shown on Figure 10.5.9, which depicts second round data, arsenic was the primary contributor to risk projections for AOC 680 groundwater. Tetrachloroethene was a secondary contributor to risk estimates for the groundwater pathways. Arsenic was the primary contributor to hazard estimates. Figure 10.5.10 illustrates point hazard estimates for groundwater for the residential scenario. Geoprobe data are provided on the risk maps and tables for completeness, however, the quantitation of these data is not considered as reliable as those resulting from the monitoring well samples.

Groundwater — Future Site Worker Scenario

Arsenic was identified as a groundwater pathway COC. Table 10.5.29 presents the risk and hazard estimates associated with all rounds of samples collected from each monitoring well. Figure 10.5.11 illustrates the point risk for groundwater pathways under a site worker scenario. Arsenic was the primary contributor to risk projections for AOC 680 groundwater. Figure 10.5.12 illustrates the point hazard index for groundwater pathways. Arsenic was also the primary contributor to hazard estimates.

10.5.8.8 Remedial Goal Options

Soil

RGOs for carcinogens were based on the lifetime weighted average site resident as presented in Table 10.5.30 for surface soil.

Groundwater

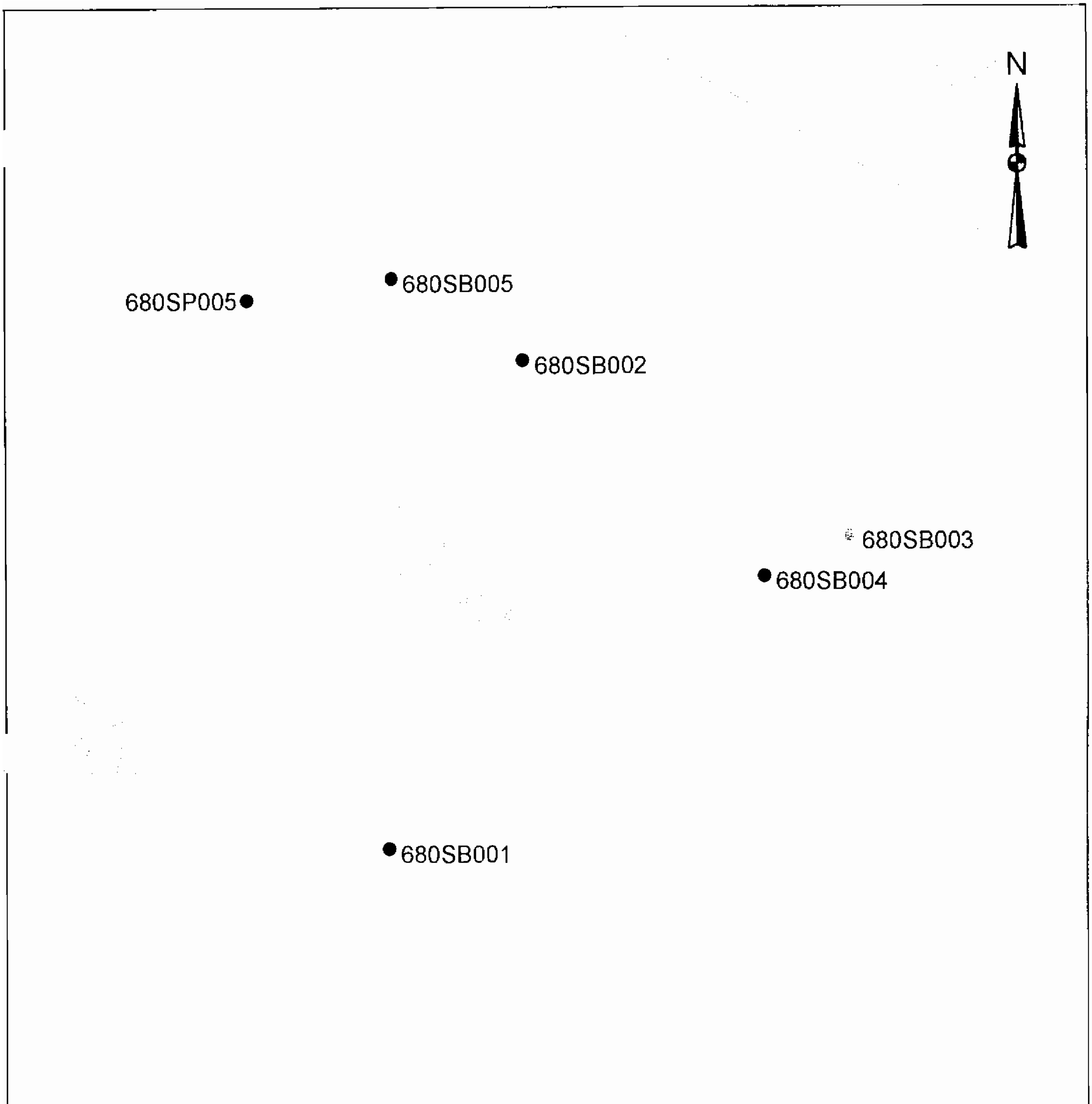
RGOs for carcinogens were based on the lifetime weighted average site resident and future site workers as presented in Table 10.5.31 for groundwater, respectively. Hazard-based RGOs for the residential scenario were calculated based on the hypothetical child receptor.

10.5.9 Corrective Measures Considerations

Based on the analytical results and the human health risk assessment for AOC 680, COCs requiring further evaluation through the CMS process have been identified for surface soil and groundwater. The site is currently in a moderately developed urban setting and risk to human health was evaluated under both the future residential and future industrial (site worker) scenarios. For these scenarios, the incidental ingestion and dermal contact exposure pathways were evaluated. Hazard was evaluated for noncarcinogenic contaminants through incidental ingestion and dermal contact scenarios as well.

As recommended by SCDHEC, a COC is considered to be any chemical contributing to a cumulative risk level of 1E-06 or greater and/or a cumulative hazard index above 1, and whose individual risk exceeds 1E-06 or whose hazard quotient exceeds 0.1.

BEQs were identified as soil pathway COCs for AOC 680. Arsenic and tetrachloroethene were identified as groundwater pathway COCs for AOC 680. Table 10.5.32 presents cumulative and COC-specific exposure risks and hazard quotients.



LEGEND

- NO COPCs
- < 1E-6
- 1E-6 to 5E-6
- 5E-6 to 1E-5
- 1E-5 to 1E-4
- > 1E-4

40 0 40 80 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.5.8
ZONE I
AOC 680

SURFACE SOIL POINT RISK
RESIDENTIAL SCENARIO

Table 10.5.27
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
AOC 680
Charleston Naval Complex,
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	Risk (E-06)
680	B001	No COPCs	ND		NA	NA
680	B002	No COPCs	ND		NA	NA
680	B003	Benzo(a)pyrene equivalents	260.37	ug/kg	NA	4.31
680	B004	No COPCs	ND		NA	NA
680	B005	Benzo(a)pyrene equivalents	1.625	ug/kg	NA	0.03
680	P005	No COPCs	ND		NA	NA

Table 10.5.28
Point Estimates of Risk and Hazard - Groundwater Pathways
Residential Scenario
AOC 680
Charleston Naval Complex
Charleston, South Carolina

Site	Location	Round	Parameter		Concentration	Units	Hazard Index	Risk (E-06)
680	P005	1	2-Butanone (MEK)		310	UG/L	0.102	NA
680	P005	1	Acetone		3800	UG/L	2.43	NA
680	P005	1	Benzene		ND	UG/L	NA	NA
680	P005	1	bis(2-Ethylhexyl)phthalate		38	UG/L	0.121	8.02
680	P005	1	Tetrachloroethene		0.64	UG/L	0.004	0.52
680	P005	1	Trichloroethene		ND	UG/L	NA	NA
				Total			2.66	8.54
680	P005	2	2-Butanone (MEK)		ND	UG/L	NA	NA
680	P005	2	Acetone		ND	UG/L	NA	NA
680	P005	2	Benzene		0.62	UG/L	0.04	0.54
680	P005	2	bis(2-Ethylhexyl)phthalate		ND	UG/L	NA	NA
680	P005	2	Tetrachloroethene		ND	UG/L	NA	NA
680	P005	2	Trichloroethene		ND	UG/L	NA	NA
				Total			0.04	0.54
680	W001	1	2-Butanone (MEK)		ND	UG/L	NA	NA
680	W001	1	Acetone		ND	UG/L	NA	NA
680	W001	1	Benzene		ND	UG/L	NA	NA
680	W001	1	bis(2-Ethylhexyl)phthalate		ND	UG/L	NA	NA
680	W001	1	Tetrachloroethene		ND	UG/L	NA	NA
680	W001	1	Trichloroethene		ND	UG/L	NA	NA
				Total			NA	NA
680	W001	2	2-Butanone (MEK)		ND	UG/L	NA	NA
680	W001	2	Arsenic (As)		51.8	UG/L	11.04	1170.82
680	W001	2	Benzene		ND	UG/L	NA	NA
680	W001	2	bis(2-Ethylhexyl)phthalate		ND	UG/L	NA	NA
680	W001	2	Tetrachloroethene		ND	UG/L	NA	NA
680	W001	2	Trichloroethene		ND	UG/L	NA	NA
				Total			11.04	1170.82
680	W002	1	2-Butanone (MEK)		ND	UG/L	NA	NA
680	W002	1	Acetone		ND	UG/L	NA	NA
680	W002	1	Benzene		ND	UG/L	NA	NA
680	W002	1	bis(2-Ethylhexyl)phthalate		ND	UG/L	NA	NA
680	W002	1	Tetrachloroethene		1.4	UG/L	0.010	1.14
680	W002	1	Trichloroethene		0.85	UG/L	0.009	0.22
				Total			0.02	1.36
680	W002	2	2-Butanone (MEK)		ND	UG/L	NA	NA
680	W002	2	Arsenic (As)		3.1	UG/L	0.66	70.07
680	W002	2	Benzene		ND	UG/L	NA	NA
680	W002	2	bis(2-Ethylhexyl)phthalate		ND	UG/L	NA	NA
680	W002	2	Tetrachloroethene		2	UG/L	0.014	1.63
680	W002	2	Trichloroethene		3	UG/L	0.032	0.77
				Total			0.71	72.46

Table 10.5.28
Point Estimates of Risk and Hazard - Groundwater Pathways
Residential Scenario
AOC 680
Charleston Naval Complex
Charleston, South Carolina

Site	Location	Round	Parameter		Concentration	Units	Hazard Index	Risk (E-06)
680	W003	1	2-Butanone (MEK)		ND	UG/L	NA	NA
680	W003	1	Acetone		ND	UG/L	NA	NA
680	W003	1	Benzene		ND	UG/L	NA	NA
680	W003	1	bis(2-Ethylhexyl)phthalate		ND	UG/L	NA	NA
680	W003	1	Tetrachloroethene		ND	UG/L	NA	NA
680	W003	1	Trichloroethene		ND	UG/L	NA	NA
				Total			NA	NA
680	W003	2	2-Butanone (MEK)		ND	UG/L	NA	NA
680	W003	2	Arsenic (As)		ND	UG/L	NA	NA
680	W003	2	Benzene		ND	UG/L	NA	NA
680	W003	2	bis(2-Ethylhexyl)phthalate		ND	UG/L	NA	NA
680	W003	2	Tetrachloroethene		ND	UG/L	NA	NA
680	W003	2	Trichloroethene		ND	UG/L	NA	NA
				Total			NA	NA
680	W004	1	2-Butanone (MEK)		ND	UG/L	NA	NA
680	W004	1	Benzene		ND	UG/L	NA	NA
680	W004	1	Tetrachloroethene		ND	UG/L	NA	NA
680	W004	1	Trichloroethene		ND	UG/L	NA	NA
				Total			NA	NA
680	W004	A1	2-Butanone (MEK)		ND	UG/L	NA	NA
680	W004	A1	Acetone		ND	UG/L	NA	NA
680	W004	A1	Benzene		ND	UG/L	NA	NA
680	W004	A1	Tetrachloroethene		ND	UG/L	NA	NA
680	W004	A1	Trichloroethene		ND	UG/L	NA	NA
				Total			NA	NA

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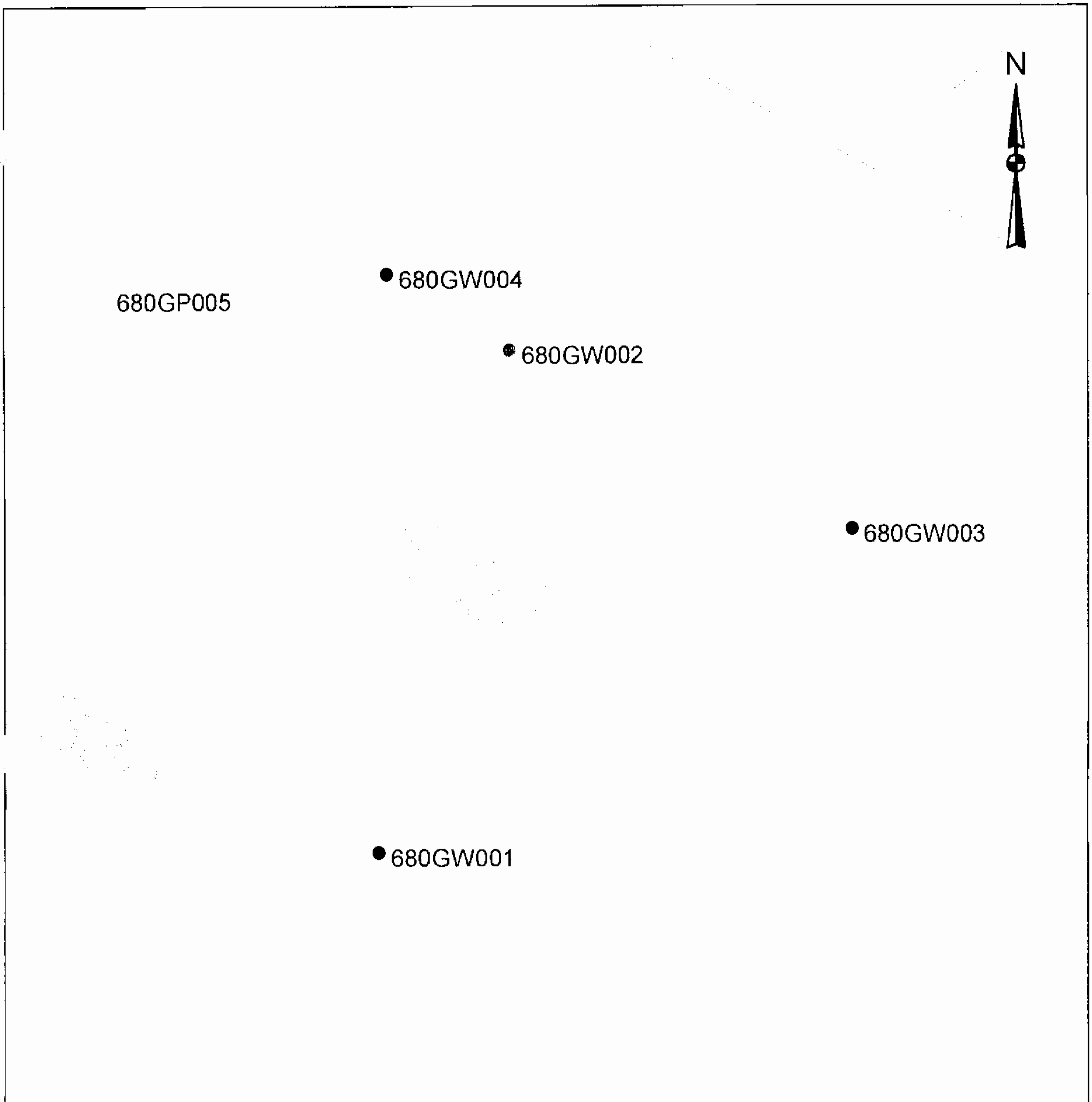


LEGEND

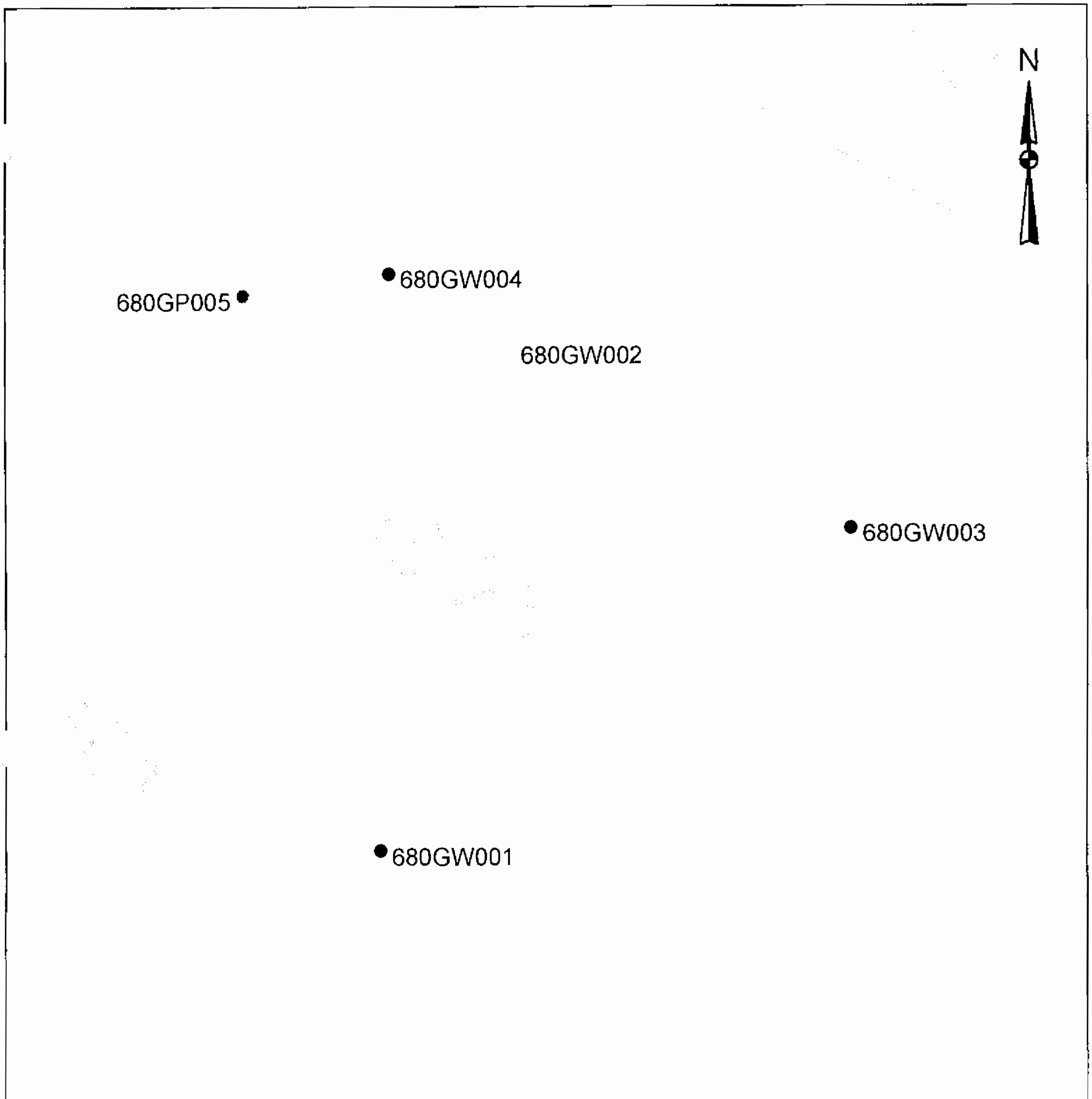
- NO COPCs
- < 1E-6
- 1E-6 to 5E-6
- 5E-6 to 1E-5
- 1E-5 to 1E-4
- > 1E-4

40 0 40 80 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.5.9
ZONE I
AOC 680

GROUNDWATER POINT RISK
RESIDENTIAL SCENARIO



LEGEND

- NO COPCs
- 0 to 0.1
- 0.1 to 0.5
- 0.5 to 1.0
- 1.0 to 3.0
- > 3.0

40 0 40 80 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.5.10
ZONE I
AOC 680

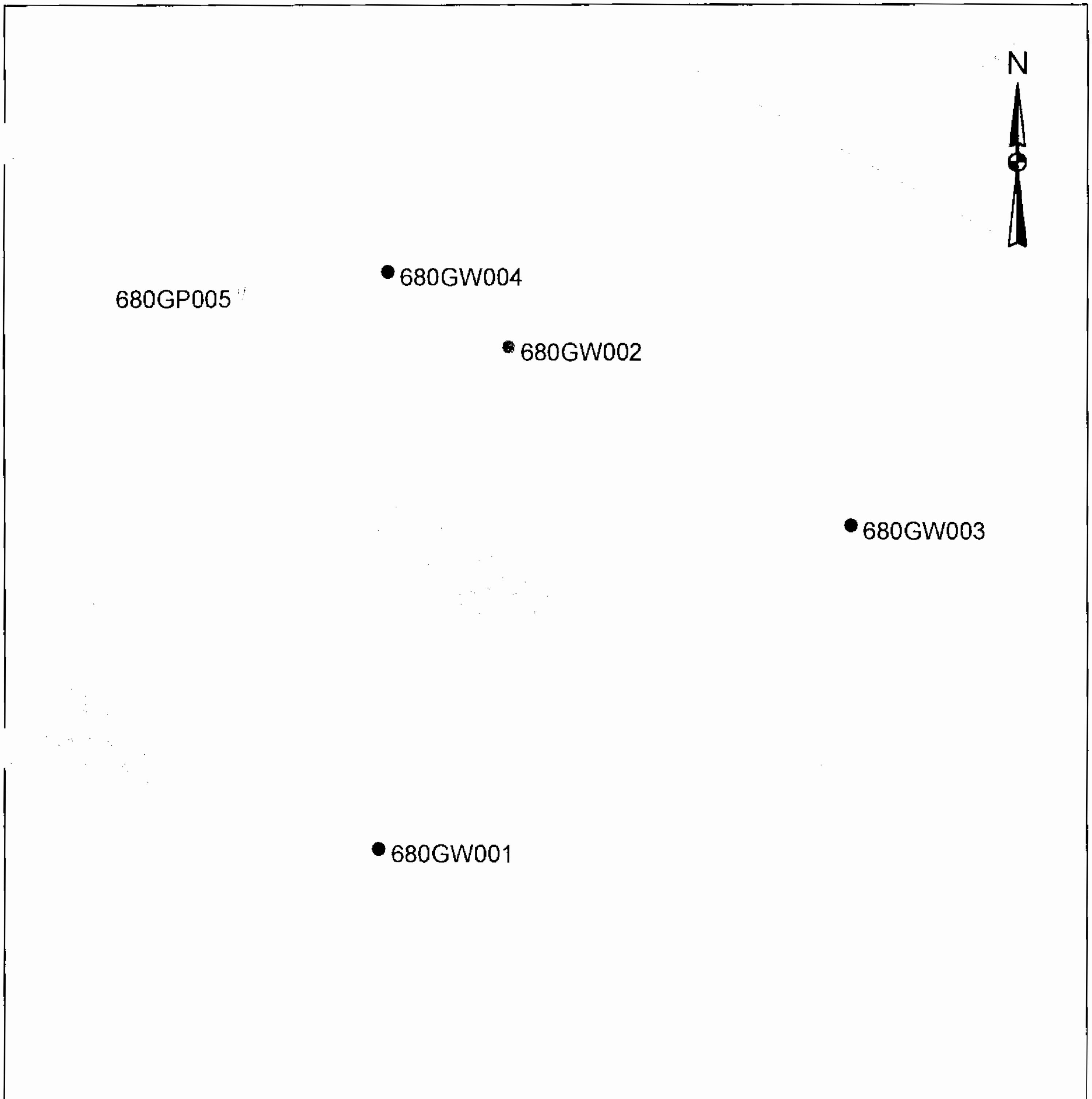
GROUNDWATER HAZARD INDEX
RESIDENTIAL SCENARIO

Table 10.5.29
Point Estimates of Risk and Hazard - Groundwater Pathways
Site Worker Scenario
AOC 680
Charleston Naval Complex
Charleston, South Carolina

Site	Location	Round	Parameter	Units	Concentration	Hazard Index	Risk (E-06)
680	P005	1	2-Butanone (MEK)	UG/L	310	0.016	NA
680	P005	1	Acetone	UG/L	3800	0.37	NA
680	P005	1	Benzene	UG/L	ND	NA	NA
680	P005	1	bis(2-Ethylhexyl)phthalate	UG/L	38	0.019	1.86
680	P005	1	Tetrachloroethene	UG/L	0.64	0.0007	0.12
680	P005	1	Trichloroethene	UG/L	ND	NA	NA
			Total			0.41	1.98
680	P005	2	2-Butanone (MEK)	UG/L	ND	NA	NA
680	P005	2	Acetone	UG/L	ND	NA	NA
680	P005	2	Benzene	UG/L	0.62	0.0056	0.13
680	P005	2	bis(2-Ethylhexyl)phthalate	UG/L	ND	NA	NA
680	P005	2	Tetrachloroethene	UG/L	ND	NA	NA
680	P005	2	Trichloroethene	UG/L	ND	NA	NA
			Total			0.006	0.13
680	W001	1	2-Butanone (MEK)	UG/L	ND	NA	NA
680	W001	1	Acetone	UG/L	ND	NA	NA
680	W001	1	Benzene	UG/L	ND	NA	NA
680	W001	1	bis(2-Ethylhexyl)phthalate	UG/L	ND	NA	NA
680	W001	1	Tetrachloroethene	UG/L	ND	NA	NA
680	W001	1	Trichloroethene	UG/L	ND	NA	NA
			Total			NA	NA
680	W001	2	2-Butanone (MEK)	UG/L	ND	NA	NA
680	W001	2	Arsenic (As)	UG/L	51.8	1.69	271.53
680	W001	2	Benzene	UG/L	ND	NA	NA
680	W001	2	bis(2-Ethylhexyl)phthalate	UG/L	ND	NA	NA
680	W001	2	Tetrachloroethene	UG/L	ND	NA	NA
680	W001	2	Trichloroethene	UG/L	ND	NA	NA
			Total			1.69	271.53
680	W002	1	2-Butanone (MEK)	UG/L	ND	NA	NA
680	W002	1	Acetone	UG/L	ND	NA	NA
680	W002	1	Benzene	UG/L	ND	NA	NA
680	W002	1	bis(2-Ethylhexyl)phthalate	UG/L	ND	NA	NA
680	W002	1	Tetrachloroethene	UG/L	1.4	0.0015	0.26
680	W002	1	Trichloroethene	UG/L	0.85	0.0014	0.05
			Total			0.0029	0.31
680	W002	2	2-Butanone (MEK)	UG/L	ND	NA	NA
680	W002	2	Arsenic (As)	UG/L	3.1	0.10	16.25
680	W002	2	Benzene	UG/L	ND	NA	NA
680	W002	2	bis(2-Ethylhexyl)phthalate	UG/L	ND	NA	NA
680	W002	2	Tetrachloroethene	UG/L	2	0.0021	0.38
680	W002	2	Trichloroethene	UG/L	3	0.0049	0.18
			Total			0.11	16.81

Table 10.5.29
Point Estimates of Risk and Hazard - Groundwater Pathways
Site Worker Scenario
AOC 680
Charleston Naval Complex
Charleston, South Carolina

Site	Location	Round	Parameter	Units	Concentration	Hazard Index	Risk (E-06)
680	W003	1	2-Butanone (MEK)	UG/L	ND	NA	NA
680	W003	1	Acetone	UG/L	ND	NA	NA
680	W003	1	Benzene	UG/L	ND	NA	NA
680	W003	1	bis(2-Ethylhexyl)phthalate	UG/L	ND	NA	NA
680	W003	1	Tetrachloroethene	UG/L	ND	NA	NA
680	W003	1	Trichloroethene	UG/L	ND	NA	NA
			Total			NA	NA
680	W003	2	2-Butanone (MEK)	UG/L	ND	NA	NA
680	W003	2	Arsenic (As)	UG/L	ND	NA	NA
680	W003	2	Benzene	UG/L	ND	NA	NA
680	W003	2	bis(2-Ethylhexyl)phthalate	UG/L	ND	NA	NA
680	W003	2	Tetrachloroethene	UG/L	ND	NA	NA
680	W003	2	Trichloroethene	UG/L	ND	NA	NA
			Total			NA	NA
680	W004	1	2-Butanone (MEK)	UG/L	ND	NA	NA
680	W004	1	Benzene	UG/L	ND	NA	NA
680	W004	1	Tetrachloroethene	UG/L	ND	NA	NA
680	W004	1	Trichloroethene	UG/L	ND	NA	NA
			Total			NA	NA
680	W004	A1	2-Butanone (MEK)	UG/L	ND	NA	NA
680	W004	A1	Acetone	UG/L	ND	NA	NA
680	W004	A1	Benzene	UG/L	ND	NA	NA
680	W004	A1	Tetrachloroethene	UG/L	ND	NA	NA
680	W004	A1	Trichloroethene	UG/L	ND	NA	NA
			Total			NA	NA



LEGEND

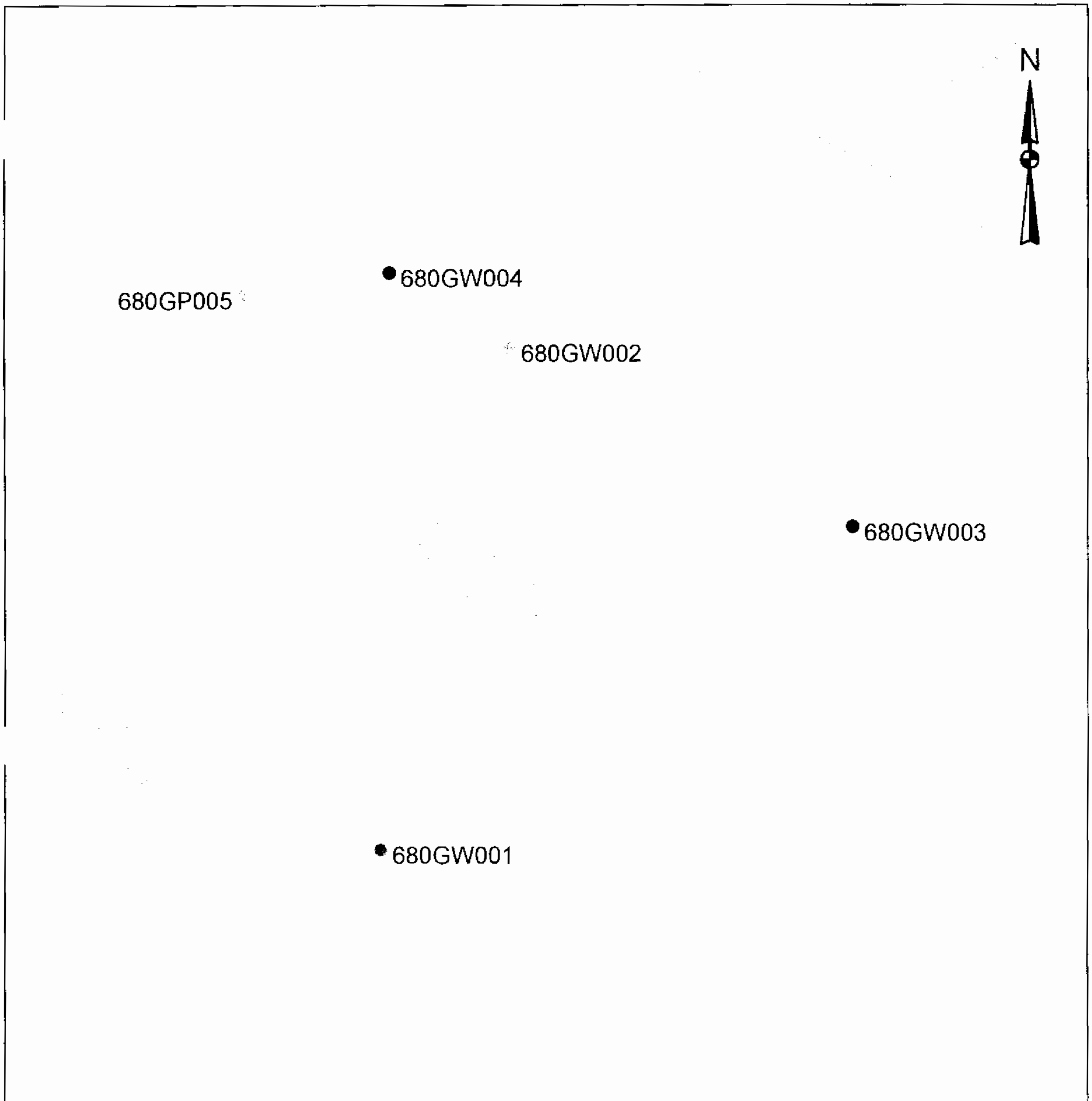
- NO COPCs
- < 1E-6
- 1E-6 to 5E-6
- 5E-6 to 1E-5
- 1E-5 to 1E-4
- > 1E-4

40 0 40 80 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.5.11
ZONE I
AOC 680

GROUNDWATER POINT RISK
INDUSTRIAL SCENARIO



LEGEND

- NO COPCs
- 0 to 0.1
- 0.1 to 0.5
- 0.5 to 1.0
- 1.0 to 3.0
- > 3.0

40 0 40 80 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.5.12
ZONE I
AOC 680

GROUNDWATER HAZARD INDEX
INDUSTRIAL SCENARIO

Table 10.5.30
Remedial Goal Options for Surface Soil
Residential Scenario
AOC 680
Charleston Naval Complex
Charleston, South Carolina

Chemical	Oral SF $(mg/kg\text{-}day)^{-1}$	Oral RfD (mg/kg-day)	EPC mg/l	Hazard-Based Remedial Goal Options			Risk-Based Remedial Goal Options			Background Concentration mg/l
				0.1 mg/l	**1.0** mg/l	**3** mg/l	**1E-06** mg/l	**1E-05** mg/l	**1E-04** mg/l	
Benzo(a)pyrene equivalents	7.3	NA	0.23	ND	ND	ND	0.060	0.60	6.0	NA

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined
\- remedial goal options were based on the residential lifetime weighted average for carcinogens

Table 10.5.31
Remedial Goal Options for Groundwater
AOC 680
Charleston Naval Complex
Charleston, South Carolina

Residential Based RGOs

Chemical	Oral SF $(mg/kg\text{-}day)^{-1}$	Oral RfD (mg/kg-day)	EPC mg/l	Hazard-Based Remedial Goal Options **0.1** mg/l	**1.0** mg/l	**3** mg/l	Risk-Based Remedial Goal Options **1E-06** mg/l	**1E-05** mg/l	**1E-04** mg/l	MCL mg/l	**Background Concentration mg/l**
Inorganics											
Arsenic	1.5	0.0003	0.05	0.00047	0.0047	0.014	0.000044	0.00044	0.0044	0.05	0.023
Volatile Organics											
Tetrachloroethene	0.052	0.01	0.0020	0.015	0.15	0.44	0.0012	0.012	0.12	0.005	NA

Site Worker Based RGOs

Chemical	Oral SF $(mg/kg\text{-}day)^{-1}$	Oral RfD (mg/kg-day)	EPC mg/l	Hazard-Based Remedial Goal Options **0.1** mg/l	**1.0** mg/l	**3** mg/l	Risk-Based Remedial Goal Options **1E-06** mg/l	**1E-05** mg/l	**1E-04** mg/l	MCL mg/l	**Background Concentration mg/l**
Inorganics											
Arsenic	1.5	0.0003	0.05	0.0031	0.031	0.31	0.00019	0.0019	0.019	0.05	0.023

NOTES:
EPC exposure point concentration
NA not applicable
ND not determined
\- remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident for noncarcinogens

Risk-based remedial goals for surface soil and groundwater are presented in Tables 10.5.30 and 10.5.31. Potential corrective measures for soil are presented in Table 10.5.33.

Table 10.5.32
AOC 680
Cumulative and Chemical-Specific Exposure Risks and Hazard

	Risk		Hazard	
Chemical	**Industrial**	**Residential**	**Industrial**	**Residential**
Soil				
BEQs	7.7E-7	3.8E-6	ND	ND
Cumulative	7.7E-7	3.8E-6	ND	ND
Groundwater				
Arsenic	2.7E-4	1.2E-3	1.7	11
Tetrachloroethene	3.7E-7	1.6E-6	0.0021	0.014
Cumulative	2.7E-4	1.2E-3	1.7	11

Note:
ND = Not detected

Table 10.5.33
AOC 680
Potential Corrective Measures

Medium	Compounds	Potential Corrective Measures
Soil	BEQs	a) No action b) Excavate, offsite disposal, and monitoring c) Containment/capping
Groundwater	Arsenic, Tetrachloroethene	a) No action b) Monitoring c) Ex-situ physical/chemical treatment and discharge to POTW d) Ex-situ physical/chemical treatment and discharge through NPDES permitting

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10.6 AOC 681, Building 681 Blast Booth

AOC 681 is the abrasive blast booth on the west side of Building 681 used for stripping miscellaneous ship and boiler components. The blasting agent (aluminum oxide) is recycled through a cyclone separator and the generated wastes, primarily paint dust, are directed into an outdoor hopper and then into 55-gallon drums for disposal.

Building 681 was constructed in 1985 to serve as a shop and administration building for Shore Intermediate Maintenance Activity (SIMA). The facility contained a hose shop; a canvas shop; a tool storage area; a valve shop; a lagging shop; an air conditioning and recovery shop; a hydraulics shop; a paint booth; a blasting booth; a pump shop; a machine shop; an electrical shop; and a varnish dip tank. The facility is currently used as a vessel support facility for the U.S. Coast Guard.

Two underground storage tanks (681-1 and 681-2) were associated with this facility. The tanks were installed in 1985, when the facility was constructed. Both tanks were closed by removal in early 1997.

UST 681-1 was an unregulated 100 gallon waste oil tank located on the southeast side of Building 681.

UST 681-2 was an unregulated 20,000 gallon fuel oil tank located on the south side of Building 681. It stored fuel oil for boilers located in Buildings 681 and 680.

Building 680, which is located on the west side of Building 681, was constructed in 1975 and is used for maintenance activities similar to those conducted in Building 681. Engine parts and other equipment are cleaned in dip tanks and/or are sandblasted clean as part of repair and maintenance programs.

An oil/water separator is reportedly located between Buildings 680 and 681 and services both buildings.

In addition, a sanitary and industrial sewer system site plan map from 1968 indicates that an oil/water separator and associated UST was located just at the northeast corner of what is now Building 681.

Materials of concern are lead-based paint and aluminum oxide in the blast booth area and solvents and petroleum products associated with the maintenance activities. Potential receptors include current or future site workers involved in invasive activities or working in or near the blast booth. Average particulate air emissions from the booth are 0.0004 pounds per hour or 0.00175 tons per year (*Final Zone I RFI Work Plan*, E/A&H, February 1995).

To fulfill RFI objectives, soil, groundwater, and dust were sampled in accordance with the *Final Zone I RFI Work Plan*, (E/A&H, February 1995), and Section 3 of this report. Sampling was conducted to confirm the presence of any contamination from the onsite activities.

10.6.1 Soil Sampling and Analysis

Soil was sampled in four rounds in the area around AOC 681 and from area surrounding grid-based wells GDI013 and GDI13D. These locations shown on Figure 10.6.1. The *Final Zone I RFI Work Plan* (E/A&H, February 1995) proposed three soil samples collected from the upper interval and three from the lower interval. During the first round of soil sampling, three samples were collected from the upper interval and two samples were collected from the lower interval. The third proposed lower interval sample was not collected due to a water table less than 5 feet bgs; saturated samples were not submitted for analysis. Samples were analyzed for organotins and the standard suite of chemicals, which includes VOCs, SVOCs, metals, cyanide, pesticides, and PCBs at DQO Level III. Table 10.6.1 summarizes the four rounds of soil sampling.

Table 10.6.1
AOC 681
Soil Sampling Summary

Sampling Round	Sampling Date	Samples Collected	Sample Analyses	Comments
1	03/01/95	upper-3 (3) lower-2 (3)	Organotins, Standard Suite	
2	06/21/95 06/22/95	upper-2 (2)	Pesticides, SVOCs, VOCs, TPH-DRO	Boring 681SB004 analyzed for SVOCs only.
		Duplicate-1	Appendix 9	
3	03/18/98	upper-3 lower-3	VOCs, SVOCs	Samples collected using direct push technology.
4	09/23/98 09/24/98 10/06/98	upper-6 lower-5	Standard Suite	
		Duplicate-1	Standard Suite	

Notes:
( ) = Parenthesis indicated number of samples proposed.
Standard Suite = VOCs, SVOCs, metals, cyanide, pesticides and PCBs at DQO Level III.
Appendix IX = Standard Suite, plus hex-chrome, dioxins, herbicides, and OP pesticides at DQO Level IV.
Physical parameters analyses included CEC, chloride, sulfur, ammonia, nitrate/nitrite, phosphorus, TOC and total moisture.

Second-round sampling was performed at AOC 681 after first-round analytical results were compared to the USEPA Region III RBCs (March, 1995). This comparison showed that soil sample 681SB00102 contained PAHs above their respective RBCs, justifying the collection of additional samples for SVOCs exceeding RBCs during first-round sampling. Two additional soil borings were drilled during the second round of sampling.

Because of the uncertainty of the locations of the subsurface utilities, lower interval samples were inaccessible and only two additional upper interval additional samples were collected. Sample 681SB00401 was collected for SVOC analysis. A duplicate was also collected from this location for Appendix IX analyses at DQO Level IV.

Sample 681SB00501 collected during second-round sampling after an empty oil/water separator line was breached while coring through asphalt to collect soil samples. This sample was analyzed for pesticides, SVOCs, TPH, and VOCs to determine the extent, if any, of a release. Analytical results indicate no impact occurred as a result of the line breach.

A third-round of geoprobe soil sampling was conducted in the area surrounding GDI013 after VOCs and SVOCs were detected in groundwater samples collected at this grid-based well location, which is adjacent to AOC 681. Soil samples originally collected from the location of GDI013 boring did not indicate elevated concentrations of VOCs and SVOCs, however, additional soil samples were collected from the area while groundwater samples were being collected with a geoprobe sampler. Three upper and three lower interval soil samples were collected using a geoprobe sampler (DPT) and analyzed for VOCs and SVOCs. Duplicate samples were not collected during this sampling event.

A fourth round of soil sampling was conducted as a result of new information that indicated the presence of former oil/water separators and USTs on the north and east side of Building 681. Additional samples were also collected in the area between Buildings 680 and 681 to further delineate the extent of contamination. Six upper level and five lower level samples were collected. These samples were analyzed for VOCs, SVOCs, metals, cyanide, pesticides and PCBs.

Grid-based soil-boring (GDISB013) was drilled in the area of AOC 681 as noted in Figure 10.6.1. Upper and lower interval samples from this boring were analyzed for the Standard Suite of parameters. Results of these analyses are presented in the Nature and Extent of Contamination discussion. Appendix D contains the complete analytical data report.

In addition to the samples collected as part of the RFI effort, the Environmental Detachment Charleston (DET) was tasked with collecting additional surface soil samples adjacent to and inside

Building 681. The DET collected six surface soil samples, two outside and four inside Building 681 in May, 1999.

10.6.2 Nature and Extent of Contamination in Soil

Organic compound analytical results for soil are summarized in Table 10.6.2. Inorganic analytical results for soil are summarized in Table 10.6.3. Table 10.6.4 summarizes all analytes detected in soil at AOC 681. Appendix D contains complete analytical data report for all samples collected in Zone I.

Table 10.6.2
AOC 681
Organic Compound Analytical Results for Soil (μg/kg)

Compound	Sampling Interval	Frequency of Detection	Range of Detection	Mean	RBC (Upper) SSL (Lower)	Number of Samples Exceeding RBC or SSL
Volatile Organics						
Acetone	Upper	2/14	12 - 48	30	780,000	0
	Lower	5/9	7 - 54	27.6	8,000	0
Carbon Disulfide	Upper	1/17	1	1	780,000	0
	Lower	0/6	ND	ND	16,000	0
Toluene	Upper	3/14	2	2	1,600,000	0
	Lower	1/9	2	2	6,000	0
Xylene	Upper	1/14	3.3	3.3	16,000,000	0
	Lower	2/9	2.6 - 3.6	3.1	70,000	0
Semivolatile Organics						
Acenaphthene	Upper	1/14	140	140	470,000	0
	Lower	2/9	330 - 3,800	2,065	290,000	0
Acetophenone	Upper	0/14	ND	ND	780,000	0
	Lower	1/9	41	41	0.12	1
Anthracene	Upper	1/14	640	640	2,300,000	0
	Lower	1/9	4,900	4,900	5,900,000	0
Benzo(g,h,i)perylene	Upper	1/14	850	850	310,000	0
	Lower	1/9	3,800	3,800	1.2E+8	0

Table 10.6.2
AOC 681
Organic Compound Analytical Results for Soil (μg/kg)

Compound	Sampling Interval	Frequency of Detection	Range of Detection	Mean	RBC (Upper) SSL (Lower)	Number of Samples Exceeding RBC or SSL
BEQ[a]	Upper	4/14	69.2 - 3,445	945	87	3
	Lower	1/9	16,783	16,783	1,600	1
Benzo(a)anthracene	Upper	4/14	60 - 2,900	784	870	1
	Lower	1/9	18,000	1,800	800	1
Benzo(a)pyrene	Upper	4/14	51 - 2,300	640	87	2
	Lower	1/9	11,000	11,000	4,000	1
Benzo(b)fluoranthene	Upper	4/14	110 - 2,700	792	870	1
	Lower	1/9	20,000	20,000	2,500	1
Benzo(k)fluoranthene	Upper	4/14	120 - 2,400	732	8,700	0
	Lower	1/9	22,000	22,000	25,000	0
Chrysene	Upper	4/14	48 - 3,200	862	87,000	0
	Lower	1/9	13,000	13,000	80,000	0
Indeno(1,2,3-cd)pyrene	Upper	1/14	880	880	870	1
	Lower	1/9	4,500	4,500	7,000	0
bis(2-Ethylhexyl)phthalate (BEHP)	Upper	7/14	22 - 750	205	46,000	0
	Lower	3/9	21 - 110	57	1,800,000	0
Butylbenzylphthalate	Upper	1/14	180	180	1,600,000	0
	Lower	0/9	ND	ND	930,000	0
Dibenzo(a,h)anthracene	Upper	1/14	470	470	87	1
	Lower	1/9	1,300	1,300	800	1
Dibenzofuran	Upper	1/14	54	54	31,000	0
	Lower	1/9	2,000	2,000	6,800	0
Di-n-butylphthalate	Upper	2/14	46 - 100	73	780,000	0
	Lower	2/9	63 - 65	64	2,300,000	0
Di-n-octylphthalate	Upper	1/14	30	30	160,000	0
	Lower	0/9	ND	ND	1E+7	0
Fluoranthene	Upper	6/14	25 - 7,500	1,311	310,000	0
	Lower	1/9	19,000	19,000	2,100,000	0
Fluorene	Upper	2/14	58 - 180	119	310,000	0
	Lower	1/9	3,800	3,800	280,000	0

Table 10.6.2
AOC 681
Organic Compound Analytical Results for Soil (μg/kg)

Compound	Sampling Interval	Frequency of Detection	Range of Detection	Mean	RBC (Upper) SSL (Lower)	Number of Samples Exceeding RBC or SSL
1-Methylnaphthalene	Upper	1/12	44	44	310,000	0
	Lower	1/9	620	620	72,000	0
2-Methylnaphthalene	Upper	0/14	ND	ND	310,000	0
	Lower	1/9	490	NA	230,000	0
Naphthalene	Upper	0/14	ND	ND	310,000	0
	Lower	1/9	1,500	1,500	42,000	0
3-Nitroaniline	Upper	0/14	ND	ND	23,000	0
	Lower	1/9	250	250	270	0
Phenanthrene	Upper	6/14	18 - 3,300	614	230,000	0
	Lower	1/9	15,000	15,000	660,000	0
Pyrene	Upper	8/14	19 - 5,600	764	230,000	0
	Lower	2/9	18 - 18,000	9,009	2,100,000	0
TPH-DRO	Upper	1/1	150,000	150,000	NA	0
	Lower	0/0	ND	ND	NA	0
Pesticides/PCBs						
Aldrin	Upper	0/11	ND	ND	38	0
	Lower	1/6	15	15	230	0
Aroclor 1254	Upper	1/11	190	190	320	0
	Lower	0/6	ND	ND	1000	0
beta-BHC	Upper	1/11	1	1	350	0
	Lower	0/6	ND	ND	1.3	0
delta-BHC	Upper	1/11	0.1	0.1	350	0
	Lower	0/6	ND	ND	1.8	0
gamma-BHC (Lindane)	Upper	1/11	1.1	1.1	490	0
	Lower	0/6	ND	ND	4.5	0
Chlordane	Upper	4/11	24 - 120	71	1,800	0
	Lower	0/6	ND	ND	5,000	0
alpha-Chlordane	Upper	4/11	4.7 - 160	51.2	1,800	0
	Lower	1/6	2.4	2.4	5,000	0
gamma-Chlordane	Upper	5/11	8.8 - 400	109	1,800	0
	Lower	2/6	2.1 - 5.6	3.85	5,000	0

Table 10.6.2
AOC 681
Organic Compound Analytical Results for Soil (μg/kg)

Compound	Sampling Interval	Frequency of Detection	Range of Detection	Mean	RBC (Upper) SSL (Lower)	Number of Samples Exceeding RBC or SSL
4,4'-DDD	Upper	2/11	ND	ND	2,700	0
	Lower	1/6	7.8	7.8	8,000	0
Dieldrin	Upper	3/11	1.1 - 6.5	4.5	40	0
	Lower	1/6	13	13	2	1
Endosulfan I	Upper	0/11	ND	ND	47,000	0
	Lower	1/6	32	32	9,000	0
Endosulfan II	Upper	1/11	3.6	3.6	47,000	0
	Lower	0/6	ND	ND	9,000	0
Endosulfan sulfate	Upper	1/11	1.9	1.9	47,000	0
	Lower	0/6	ND	ND	4,600	0
Endrin	Upper	1/11	0.62	0.62	2,300	0
	Lower	0/6	ND	ND	500	0
Endrin aldehyde	Upper	1/11	0.46	0.46	2,300	0
	Lower	0/6	ND	ND	340	0
Heptachlor	Upper	5/11	2.5 - 120	60.1	140	0
	Lower	1/6	3.3	3.3	11,000	0
Heptachlor epoxide	Upper	4/11	2.2 - 22	7.52	70	0
	Lower	0/6	ND	ND	330	0
Methoxychlor	Upper	0/11	ND	ND	39,000	0
	Lower	1/6	68	68	80,000	0
2,4,5-TP	Upper	1/11	0.11	0.11	63,000	0
	Lower	0/6	ND	ND	5,600	0
Dioxins						
TEQ[a]	Upper	1/1	3.2E-4	3.2E-4	4,300	0
	Lower	0/1	ND	ND	1,600,000	0

Notes:
a = Calculated from method described in USEPA *Interim Supplemental Guidance to RAGS: Region IV Bulletins, Human Health Risk Assessment*, Bulletin No. 2, November 1995
ND = Not detected
See Table 5.5 for organic compound screening concentrations and their sources.

Table 10.6.3
AOC 681
Inorganic Analytical Results for Soil (mg/kg)

Parameter	Sampling Interval	Frequency of Detection	Range of Detection	Mean	Background	RBC (upper) SSL (lower)	Number of Samples Exceeding RBC and Background (upper) or SSL and Background (lower)
Inorganics							
Aluminum	Upper	10/10	3,870 - 11,900	6,091	27,000	7,800	0
	Lower	6/6	3,590 - 11,400	6,372	18,900	560,000	0
Antimony	Upper	2/10	0.2 - 2.3	1.25	ND	3.1	0
	Lower	0/6	ND	ND	ND	2.7	0
Arsenic	Upper	8/10	1.4 - 6.6	3.59	21.6	0.43	0
	Lower	6/6	2.3 - 5.7	3.12	6.45	15	0
Barium	Upper	10/10	9.1 - 34.5	17.9	54.2	550	0
	Lower	6/6	6.4 - 18.4	13.3	36	820	0
Beryllium	Upper	7/10	0.15 - 0.63	0.3	0.95	16	0
	Lower	5/6	0.09-0.34	0.2	0.67	32	0
Cadmium	Upper	9/10	0.12 - 2.4	0.64	0.61	7.8	0
	Lower	5/6	0.1 - 0.37	0.25	0.54	4	0
Chromium	Upper	10/10	10.7 - 79.2	33.7	34.5	39	3
	Lower	6/6	7.5 - 41.1	19	51.3	19	0
Cobalt	Upper	10/10	0.97 - 26.9	7.45	5.8	470	0
	Lower	6/6	0.42 - 1.8	1.15	3.48	990	0
Copper	Upper	10/10	5.3 - 98.4	21	240	310	0
	Lower	6/6	1.5 - 28.2	9.22	11.5	5,600	0
Lead	Upper	10/10	4.2 - 39.2	17	203	400	0
	Lower	6/6	1.8 - 71.6	20.6	12.3	400	0
Manganese	Upper	10/10	23.4 - 250	105	419	160	0
	Lower	6/6	7.5 - 83.1	37.9	118	480	0
Mercury	Upper	4/10	0.06 - 0.19	0.098	0.47	2.3	0
	Lower	2/6	0.04 - 0.07	0.055	ND	1	0
Nickel	Upper	10/10	5.3 - 32.4	12.7	23.9	160	0
	Lower	6/6	2.5 - 14.5	7.25	15.7	65	0

Table 10.6.3
AOC 681
Inorganic Analytical Results for Soil (mg/kg)

Parameter	Sampling Interval	Frequency of Detection	Range of Detection	Mean	Background	RBC (upper) SSL (lower)	Number of Samples Exceeding RBC and Background (upper) or SSL and Background (lower)
Selenium	Upper	5/10	0.42 - 1.0	0.68	1.49	39	0
	Lower	3/6	0.15 - 1.1	0.57	1.77	2.6	0
Tin	Upper	1/10	1.6	1.6	7.5	4,700	0
	Lower	1/6	2.1	2.1	ND	5,500	0
Vanadium	Upper	9/10	8.4 - 44.1	18.6	113	55	0
	Lower	6/6	4.9 - 31.7	17.4	38.1	3,000	0
Zinc	Upper	10/10	20.1 - 213	55.6	206	2,300	0
	Lower	6/6	7.5 - 59.2	30.1	36.2	6,200	0

Notes:
ND = Not detected
See Table 5.6 for inorganic compound screening concentrations and their sources.

Table 10.6.4
AOC 681
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Volatile Organic Compounds (μg/kg)							
Acetone	681SP001	12	780000	NA	33	8000	NA
	681SB002	ND			54		
	681SP002	48			22		
	681SP003	ND			22		
	681SB006	ND			7		
Carbon disulfide	681SB006	ND	780000	NA	1	16000	NA
Toluene	681SB002	2	1600000	NA		6000	NA
	681SB009	2			2		
	681SB011	2					
Xylene (total)	681SP002	ND	16000000	NA	3.6	70000	NA
	681SP003	3.3			2.6		
Semivolatile Organic Compounds (μg/kg)							
Acenaphthene	681SB001	ND	470000	NA	3800	290000	NA
	681SP002	140			330		
Acetophenone	681SB001	ND	780000	NA	41	0.12	NA
Anthracene	681SB001	ND	2300000	NA	4900	5900000	NA
	681SB009	640			ND		

Table 10.6.4
AOC 681
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Benzo(g,h,i)perylene	681SB001	ND	310000	NA	3800	1.2E+08	NA
	681SB009	850			ND		
Benzo(a)pyrene Equivalents (BEQs)	681SB001	102	87	NA	16783	1600	NA
	681SB002	69.2			ND		
	681SB003	164			NS		
	681SB009	3445			ND		
Benzo(a)anthracene	681SB001	76	870	NA	**18000**	800	NA
	681SB002	60					
	681SB003	99					
	681SB009	**2900**					
Benzo(a)pyrene	681SB001	79	87	NA	11000	4000	NA
	681SB002	51					
	681SB003	130					
	681SB009	2300					
Benzo(b)fluoranthene	681SB001	140	870	NA	**20000**	2500	NA
	681SB002	110			ND		
	681SB003	220			NS		
	681SB009	2700			ND		

Table 10.6.4
AOC 681
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Benzo(k)fluoranthene	681SB001	160	8700	NA	22000	25000	NA
	681SB002	120			ND		
	681SB003	250			NS		
	681SB009	2400			ND		
Chrysene	681SB001	82	87000	NA	13000	80000	NA
	681SB002	48			ND		
	681SB003	120			NS		
	681SB009	3200			ND		
Dibenz(a,h)anthracene	681SB001	ND	87	NA	1300	800	NA
	681SB009	470			ND		
Indeno(1,2,3-cd)pyrene	681SB001	ND	870	NA	4500	7000	NA
	681SB009	880			ND		
Butylbenzylphthalate	681CB004	180	1600000	NA	NS	930000	NA
Dibenzofuran	681SB001	ND	31000	NA	2000	6800	NA
	681SP002	54			ND		
Di-n-butylphthalate	681SB001	ND	780000	NA	65	2300000	NA
	681SB002	46			ND		
	681CB004	100			NS		
	681SB006	ND			63		

Table 10.6.4
AOC 681
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Di-n-octyl phthalate	681SP001	30	160000	NA	ND	10000000	NA
bis(2-Ethylhexyl)phthalate (BEHP) c	681SB002	ND	46000	NA	110	1800000	NA
	681SP002	60			ND		
	681SB003	72			NS		
	681SB005	250			NS		
	681SB006	22			21		
	681SB007	ND			40		
	681SB008	750			NS		
	681SB009	130			ND		
	681SB011	150			ND		
Fluoranthene	681SB001	160	310000	NA	19000	2100000	NA
	681SP001	37			ND		
	681SB002	92			ND		
	681SB003	55			NS		
	681SB006	25			ND		
	681SB009	7500			ND		
Fluorene	681SB001	ND	310000	NA	3800	280000	NA
	681SP002	58			ND		
	681SB009	180			ND		

Table 10.6.4
AOC 681
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
1-Methylnaphthalene	681SB001	ND	310000	NA	620	72000	NA
	681SB005	44			NS		
2-Methylnaphthalene	681SB001	ND	310000	NA	490	23000	NA
Naphthalene	681SB001	ND	310000	NA	1500	42000	NA
3-Nitroaniline	681SB001	ND	23000	NA	250	270	NA
Phenanthrene	681SB001	92	230000	NA	15000	660000	NA
	681SP001	18			ND		
	681SB002	65			ND		
	681SP002	190			ND		
	681SB006	18			ND		
	681SB009	3300			ND		
Pyrene	681SB001	110	230000	NA	18000	2100000	NA
	681SP001	30			ND		
	681SB002	64			ND		
	681SP002	180			ND		
	681SB003	50			NS		
	681SB006	19			ND		
	681SB007	ND			18		
	681SB009	5600			ND		
	681SB011	64			ND		

Table 10.6.4
AOC 681
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Pesticides/PCBs (mg/kg)							
Aldrin	681SB001	ND	38	NA	15	230	NA
Aroclor-1254	681SB006	190	320	NA	ND	1000	NA
beta-BHC (beta-HCH)	681SB005	1	350	NA	NS	1.3	NA
gamma-BHC (Lindane)	681SB005	1.1	490	NA	NS	4.5	NA
Chlordane	681SB001	120	1800	NA	ND	5000	NA
	681SB002	89			ND		
	681SB003	51			NS		
	681CB004	24			NS		
alpha-Chlordane	681SB007	4.7	1800	NA	2.4	5000	NA
	681SB009	12			ND		
	681SB010	160			NS		
	681SB011	28			ND		
gamma-Chlordane	681SB006	8.8	1800	NA	ND	5000	NA
	681SB007	11.85			5.6		
	681SB009	33			2.1		
	681SB010	400			NS		
	681SB011	90			ND		

Table 10.6.4
AOC 681
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
4,4'-DDD	681SB009	ND	2700	NA	7.8	8000	NA
Dieldrin	681SB001	ND	40	NA	13	2	NA
	681CB004	1.1			NS		
	681SB006	6.5			ND		
	681SB011	5.9			ND		
Endosulfan I	681SB001	ND	47000	NA	32	9000	NA
Endosulfan II	681CB004	3.6	47000	NA	NS	9000	NA
Endosulfan sulfate	681CB004	1.9	47000	NA	NS	4600	NA
Endrin	681CB004	0.62	2300	NA	NS	500	NA
Heptachlor	681SB001	94	140	NA	ND	11000	NA
	681SB002	71			3.3		
	681SB009	13			ND		
	681SB010	120			NS		
	681SB011	2.5			ND		
Heptachlor epoxide	681SB007	2.15	70	NA	ND	330	NA
	681SB009	2.3			ND		
	681SB010	22			NS		
	681SB011	3.6			ND		

Table 10.6.4
AOC 681
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Methoxychlor	681SB001	ND	39000	NA	68	80000	NA
Herbicides (mg/kg)							
2,4,5-TP (Silvex)	681CB004	0.11	63000	NA	NA	5600	NA
TPH-DRO (mg/kg)							
Diesel	681SB005	150	NA	NA	NS	NA	NA
Dioxin Compounds (ng/kg)							
2,3,7,8-TCDD equivalents (TEQs)	681CB004	0.325	4.3	NA	NS	1600	NA
1234678-HpCDD	681CB004	14.1	430	NA	NS	108000	NA
OCDD	681CB004	124	4300	NA	NS	1080000	NA
1234678-HpCDF	681CB004	4.89	430	NA	NS	54000	NA
OCDF	681CB004	10.1	4300	NA	NS	540000	NA
Inorganics (mg/kg)							
Aluminum (Al)	681SB001	3870	7800	27400	3820	560000	18900
	681SB002	5380			3590		
	681SB003	4480			NS		
	681CB004	4360			NS		
	681SB006	8080			11400		
	681SB007	5135			5500		
	681SB008	11900			NS		
	681SB009	3880			5330		
	681SB010	4450			NS		
	681SB011	9380			8590		

Table 10.6.4
AOC 681
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Antimony (Sb)	681CB004	0.23	3.1	ND	ND	2.7	ND
	681SB011	2.3			ND		
Arsenic (As)	681SB001	ND	0.43	21.6	3.8	15	6.45
	681SB002	ND			5.2		
	681SB003	4.2			NS		
	681CB004	2.7			NS		
	681SB006	1.4			2.3		
	681SB007	2.55			3.2		
	681SB008	3.7			NS		
	681SB009	4			3.7		
	681SB010	3.5			NS		
	681SB011	6.6			2.7		
Barium (Ba)	681SB001	9.1	550	54.2	13.2	820	36
	681SB002	23.1			6.4		
	681SB003	10.7			NS		
	681CB004	13.2			NS		
	681SB006	16.3			18.4		
	681SB007	21.35			13.2		
	681SB008	19			NS		
	681SB009	18.3			12.5		
	681SB010	12.5			NS		
	681SB011	34.5			16.3		

Table 10.6.4
AOC 681
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Beryllium (Be)	681SB002	0.34	16	0.95	0.25	32	0.67
	681SB003	0.24			NS		
	681SB006	0.15			0.11		
	681SB007	ND			0.19		
	681SB008	0.63			NS		
	681SB009	0.28			0.34		
	681SB010	0.27			NS		
	681SB011	0.2			0.09		
Cadmium (Cd)	681SB001	0.12	7.8	0.61	0.1	4	0.54
	681SB002	0.16			0.25		
	681SB003	0.33			NS		
	681SB006	0.23			0.29		
	681SB007	0.4			0.25		
	681SB008	0.76			NS		
	681SB009	0.95			0.37		
	681SB010	0.38			NS		
	681SB011	2.4			ND		

Table 10.6.4
AOC 681
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Chromium (Cr) (total)	681SB001	10.7	39	34.5	7.5	19	51.3
	681SB002	15.7			24.3		
	681SB003	26.7			NS		
	681CB004	22.4			NS		
	681SB006	14.3			11.3		
	681SB007	17.85			21		
Chromium (Cr) (total)	6812B008	**79.2**			NS		
	681SB009	**44.1**			41.1		
	681SB010	32.6			NS		
	681SB011	**73.5**			8.8		
Cobalt (Co)	681SB001	1.5	470	5.8	1.2	990	3.48
	681SB002	1.7			0.9		
	681SB003	1			NS		
	681CB004	1			NS		
	681SB006	1.7			0.42		
	681SB007	0.97			1.4		
	681SB008	2.5			NS		
	681SB009	26.9			1.8		
	681SB010	25.8			NS		
	681SB011	11.4			1.2		

Table 10.6.4
AOC 681
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Copper (Cu)	681SB001	6.7	310	240	28.2	5600	11.5
	681SB002	6.6			7		
	681SB003	10.5			NS		
	681CB004	10.4			NS		
	681SB006	16			1.5		
	681SB007	5.3			8.5		
	681SB008	13.2			NS		
	681SB009	37.2			7.4		
	681SB010	5.9			NS		
	681SB011	98.4			2.7		
Lead (Pb)	681SB001	11.3	400	203	71.6	400	12.3
	681SB002	6.1			1.8		
	681SB003	7.4			NS		
	681CB004	31.1			NS		
	681SB006	25			12.5		
	681SB007	28.3			6		
	681SB008	4.2			NS		
	681SB009	5.9			8.4		
	681SB010	11.5			NS		
	681SB011	39.2			23.5		

Table 10.6.4
AOC 681
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Manganese (Mn)	681SB001	59.7	160	419	13.5	480	118
	681SB002	81			67.8		
	681SB003	79.5			NS		
	681CB004	47.8			NS		
	681SB006	23.4			9.3		
	681SB007	40.65			45.9		
	681SB008	107			NS		
	681SB009	184			83.1		
	681SB010	173			NS		
	681SB011	250			7.5		
Mercury (Hg)	681SB006	0.06	2.3	0.47	0.04	1	ND
	681SB007	0.08			0.07		
	681SB008	0.19			NS		
	681SB011	0.06			ND		
Nickel (Ni)	681SB001	5.3	160	23.9	3.5	65	15.7
	681SB002	5.8			12.7		
	681SB003	11.4			NS		
	681CB004	8.6			NS		
	681SB006	5.6			2.9		
	681SB007	6.7			7.4		

Table 10.6.4
AOC 681
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Nickel (Ni) (Continued)	681SB008	27.2			NS		
	681SB009	12			14.5		
	681SB010	12.2			NS		
	681SB011	32.4			2.5		
Selenium (Se)	681SB002	0.68	39	1.49	1.1	2.6	1.77
	681SB003	1			NS		
	681CB004	0.66			NS		
	681SB006	ND			0.46		
	681SB007	0.42			0.15		
	681SB008	0.65			NS		
Tin (Sn)	681SB001	ND	4700	7.5	2.1	5500	ND
	681CB004	1.6			NS		
Vanadium (V)	681SB001	8.4	55	113	4.9	3000	38.1
	681SB002	18.1			13.9		
	681SB003	17.2			NS		
	681SB006	13.8			31.7		
	681SB007	10.55			12.7		
	681SB008	44.1			NS		
	681SB009	16.4			27.6		
	681SB010	16			NS		
	681SB011	22.9			13.4		

Table 10.6.4
AOC 681
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Zinc (Zn)	681SB001	52.7	2300	206	59.2	6200	36.2
	681SB002	20.1			34.8		
	681SB003	35.7			NS		
	681CB004	33.3			NS		
	681SB006	38.9			7.5		
	681SB007	25.8			29.3		
	681SB008	68.2			NS		
	681SB009	42.5			32.7		
	681SB011	119			17		

Notes:
* = Residential RBCs (THQ=0.1) were used as a reference concentration for upper interval samples. Generic soil-to groundwater SSLs (DAF=10) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996b) were used as s reference concentration for lower interval samples
Bolded concentrations exceed the RBCs, SSL and the zone background
NA = Not applicable/Not available
ND = Not detected
NS = Not sampled
NL = Not listed
RBC = Risk-Based Concentrations
SSL = Soil Screening Level

Volatile Organic Compounds in Soil

No VOCs were detected in soil samples at AOC 681 above their respective RBCs or SSLs. Two VOCs were detected in soil samples collected at grid-based well GDI013, however, they did not exceeded their respective SSLs.

Semivolatile Organic Compounds in Soil

Twenty-one SVOCs were detected in AOC 681 surface soil samples. The following PAHs exceeded their respective RBCs: benzo(a)anthracene (2,900 μg/kg), benzo(a)pyrene (2,300 μg/kg), benzo(b)fluoranthene (2,700 μg/kg), dibenzo(a,h)anthracene (407 μg/kg), and indeno(1,2,3-cd)pyrene (880 μg/kg). Each of these exceedances occurred at boring 681SB00901. No other SVOCs exceeded their RBC in the surface soil samples and no SVOCs were detected in grid boring GDI013.

Twenty-four SVOCs were detected in subsurface soil samples. Again, only PAHs exceeded their respective SSLs. Benzo(a)anthracene (18,000 μg/kg), benzo(a)pyrene (11,000 μg/kg), benzo(b)fluoranthene (20,000 μg/kg), benzo(k)fluoranthene (22,000 μg/kg), and dibenzo(a,h)anthracene (1,300 μg/kg), all in boring 681SB00102. No other subsurface SVOCs exceeded their SSL.

In accordance with recent cPAH guidance (USEPA *Interim Supplemental Guidance to RAGS: Region IV Bulletins, Human Health Risk Assessment,* Bulletin No. 2 [USEPA, 1995c]) and Section 7 of this report, BEQs were calculated for cPAHs at AOC 681. The BEQ for sample 681SB00101 is 102 μg/kg, 681SB00201 is 69.2 μg/kg, 681SB00301 is 164 μg/kg, and 681SB00901 is 3,445 μg/kg. Three samples exceed the RBC of 87 μg/kg. The BEQ for 681SB00102 is 16,783 μg/kg, which exceeds the SSL of 1,600 μg/kg. These detections are concentrated in the area between Buildings 680 and 681.

Pesticides and PCBs in Soil

Seventeen pesticides were detected in surface soils at AOC 681. No detections exceeded their RBC. Seven pesticides were detected in subsurface soil samples. None exceeded their SSL. Three pesticides were detected in soil samples collected at grid-based well GDI013, however, none of these exceeded their respective RBCs.

Other Organic Compounds in Soil

Dioxins and furans were detected in the duplicate sample collected at boring 681SB004. In accordance with recent dioxin guidance and Section 7 of this report, TEQs were calculated. The TEQ for 681SB00401 is 3.20E-4 μg/kg, which is well below the RBC of 4,300 μg/kg.

TPH was detected at 150 mg/kg in sample 681SB00501.

Inorganic Elements in Soil

Seventeen metals were detected in surface soil samples at AOC 681. Only one sample exceeded its RBC and background. Chromium (total) was detected at 73.5 μg/kg in sample 681SB01101. Eleven metals were detected in Grid boring GDISB01301. None exceeded their respective RBC and background values.

Sampling By Others

The DET collected six additional surface soil samples adjacent to and/or inside Building 681 in the vicinity of boring 681SB009. A copy of the DET sampling report has been included as an attachment to this report. The samples were analyzed for SVOCs only (due to the levels of PAHs detected in 681SB009). The calculated BEQs for these six samples ranged from ND to 94.9 μg/kg (which exceeds the RBC of 87 μg/kg) was underneath Building 681. This indicates that the contamination extends under the building on the southwest corner.

10.6.3 Groundwater Sampling and Analysis

The *Final Zone I RFI Work Plan* (E/A&H, February 1995) did not propose any site-specific wells at AOC 681, however, in accordance with the work plan, a grid-based monitoring well pair, GDI013 and GDI13D, was installed adjacent to AOC 681 to characterize the zone perimeter groundwater. Based on the detection of VOCs and SVOCs in samples collected from GDI013 and GDI13D, three shallow (8 to 10 feet) and three deep (14 to 16 feet) groundwater samples were also collected using a geoprobe sampler to delineate the area surrounding the grid-based well pair. Samples collected with the geoprobe sampler were analyzed for VOCs and SVOCs only. Three monitoring wells were installed in late 1998 to help further delineate the extent of contamination at AOC 681. These monitoring wells were sampled in three rounds in 1998 and 1999. Table 10.6.5 summarizes the groundwater sampling at AOC 681. Figure 10.6.1 illustrates the sample locations.

Table 10.6.5
AOC 681
Groundwater Sampling Summary

Sampling Round	Sampling Date	Number of Wells	Sample Analyses	Comments
1	03/18/99	Geoprobe-3	VOCs, SVOCs	3 shallow and 3 deep samples collected
2	10/20/98	3	VOCs, SVOCs, Metals, Cyanide	3 shallow wells installed to further delineate the extent of contamination
3	01/25/99 01/26/99	3	VOCs, SVOCs, pesticides, metals, cyanide	
4	06/02/99	3	VOCs, SVOCs, Metals, Cyanide	

10.6.4 Nature and Extent of Contamination in Groundwater

Table 10.6.6 summarizes the groundwater analytical results for organics and inorganics detected in shallow groundwater. Table 10.6.7 summarizes the groundwater analytical results for organics detected in shallow geoprobe groundwater samples and Table 10.6.8 summarizes the analytical results for organics detected in deep geoprobe groundwater samples. Appendix D is a complete analytical data report for all samples collected in Zone I.

Table 10.6.6
AOC 681
Analytes Detected in Shallow Groundwater (μg/l)

Parameters	Location	1st Round Conc.	2nd Round Conc.	3rd Round Conc.	Tap Water RBC*	MCL/SMCL*	Shallow Background
Volatile Organic Compounds							
Carbon disulfide	681GW001	2	ND	ND	100	NA	NA
Semivolatile Organic Compounds							
bis(2-Ethylhexyl)phthalate (BEHP)	681GW002	22	1	ND	4.8	NA	NA
	681GW003	ND	3	ND			
4-Nitrophenol	681GW003	ND	4	ND	29.2	NL	NA
Inorganics							
Aluminum (Al)	681GW001	ND	ND	53.2	3700	NL	1440
	681GW003	131	72.2	ND			
Arsenic (As)	681GW001	7.5	ND	8.1	0.045	50	23
	681GW002	3.3	3.8	ND			
	681GW003	4.3	4.7	ND			
Barium (Ba)	681GW001	ND	12.7	10.6	260	2000	110
	681GW002	32.7	26.3	53.6			
	681GW003	41	34.9	39			
Cobalt (Co)	681GW003	ND	1.7	ND	220	NL	2.2
Copper (Cu)	681GW002	ND	10.1	ND	150	1300	4.4
	681GW003	ND	2.1	ND			
Lead (Pb)	681GW002	ND	ND	3.3	15	15	4.4
Manganese (Mn)	681GW001	9.7	10.6	4.3	73	NL	5430
	681GW002	44.1	29.6	56.9			
	681GW003	64.9	89.2	73.6			

Table 10.6.6
AOC 681
Analytes Detected in Shallow Groundwater (μg/l)

Parameters	Location	1st Round Conc.	2nd Round Conc.	3rd Round Conc.	Tap Water RBC*	MCL/SMCL*	Shallow Background
Mercury (Hg)	681GW002	ND	ND	0.13	1.1	2	NA
	681GW003	ND	ND	0.2			
Nickel (Ni)	681GW002	ND	2.3	ND	73	100	13.3
	681GW003	ND	2.1	ND			
Selenium (Se)	681GW003	ND	ND	2.9	18	50	ND
Silver (Ag)	681GW002	6.1	ND	ND	18	NL	NA
	681GW003	ND	ND	2.3			
Thallium (Tl)	681GW003	ND	ND	2.4	0.26	2	6.6
Vanadium (V)	681GW001	ND	ND	9.6	26	NL	14
	681GW002	ND	1.3	ND			
	681GW003	ND	ND	1.1			
Zinc (Zn)	681GW003	ND	13.7	ND	1100	NL	24.4

Notes:

* = Tap Water RBCs (THQ=0.1) from *Risk-Based Concentration Table* (USEPA, October 22, 1997), and MCLs/SMCLs from *Drinking Water Regulations and Health Advisories* (USEPA, 1996e)

Bolded concentrations exceed the RBCs, SSL and the zone background

NA = Not applicable
ND = Not detected
NL = Not listed
RBC = Risk-Based Concentration
MCL = Maximum Contaminant Levels
SMCL = Secondary Maximum Contaminant Levels

Table 10.6.7
AOC 681 Geoprobe Samples
Analytes Detected in Shallow Groundwater (μg/l)

Parameters	Location	Concentration	Tap Water RBC*	MCL/SMCL*	Shallow Background
Volatile Organic Compounds					
Acetone	681GP001	7	370	NA	NA
	681GP002	9.9			
	681GP003	6.7			
Semivolatile Organic Compounds					
Acenaphthene	681GP002	53	220	NA	NA
Dibenzofuran	681GP002	**13**	2.4	NA	NA
Fluorene	681GP002	10	150	NA	NA
Phenanthrene	681GP002	0.91	110	NA	NA

Notes:
* = Tap Water RBCs (THQ=0.1) from *Risk-Based Concentration Table* (USEPA, October 22, 1997), and MCLs/SMCLs from *Drinking Water Regulations and Health Advisories* (USEPA, 1996e)
Bolded concentrations exceed the RBCs, SSL and the zone background
NA = Not applicable/Not available
MCL = Maximum Contaminant Levels
RBC = Risk-Based Concentration
SMCL = Secondary Maximum Contaminant Levels

Table 10.6.8
AOC 681 Geoprobe Samples
Analytes Detected in Deep Groundwater (µg/l)

Parameters	Location	Concentration	Tap Water RBC*	MCL/SMCL*	Deep Background
Volatile Organic Compounds					
Acetone	681GP002	8.3	370	NA	NA
	681GP003	5.4			
	681GP005	57			
Carbon disulfide	681GP001	0.62	100	NA	NA
Semivolatile Organic Compounds					
Acenaphthene	681GP002	19	220	NA	NA
Dibenzofuran	681GP002	3	2.4	NA	NA
bis(2-Ethylhexyl)phthalate (BEHP)	681GP005	0.78	4.8	NA	NA
Fluoranthene	681GP002	0.53	150	NA	NA
Fluorene	681GP002	3.1	150	NA	NA
Naphthalene	681GP002	0.57	150	NA	NA
Phenanthrene	681GP002	1.3	110	NA	NA

Notes:
* = Tap Water RBCs (THQ=0.1) from *Risk-Based Concentration Table* (USEPA, October 22, 1997), and MCLs/SMCLs from *Drinking Water Regulations and Health Advisories* (USEPA, 1996e)
Bolded concentrations exceed the RBCs, SSL and the zone background
NA = Not applicable/Not available
MCL = Maximum Contaminant Levels
RBC = Risk-Based Concentration
SMCL = Secondary Maximum Contaminant Levels

Volatile Organic Compounds in Groundwater

Only one VOC was detected in shallow monitoring well samples at AOC 681. Carbon disulfide was detected at 2 μg/L in 681GW00101, well below the tap water RBC. Acetone was detected in all three shallow geoprobe groundwater samples collected in the area surrounding grid-based well GDI013, however, none of the three exceeded the tap water RBC of 370 μg/L. One VOC, 1,2-Dichloroethane, was detected in GDI013 during the fourth sampling event, but did not exceed its tap water RBC of 5 μg/L.

Two VOCs were detected in deep groundwater samples at AOC 681. Acetone and carbon disulfide were detected in the deep geoprobe samples, however, neither exceeded their respective RBC. Carbon disulfide was detected in grid-based deep well GDI13D during the fifth sampling event, but did not exceed its RBC. Chloroethane was detected in the grid-based well in the first round at 6.0 μg/L, which exceeds the tap water RBC (3.6 μg/L).

Semivolatile Organic Compounds in Groundwater

Two SVOCs were detected in shallow monitoring well samples at AOC 681. BEHP in wells 681GW003 and 681GW003, and 4-nitrophenol in well 681GW003. BEHP was detected at 22 μg/L in well 681GW00201, which exceeds the tap water RBC of 4.8 μg/L. No other detections exceeded their RBC and/or MCL.

Four SVOCs were detected in shallow geoprobe groundwater samples at AOC 681, however, none of the four exceeded their respective tap water RBC. Two SVOCs, benzoic acid (third and fourth quarters) and 2,4,6-trichlorophenol (second quarter), were detected in shallow grid-based well GDI013, however, neither exceeded its tap water RBC.

Six SVOCs were detected in deep groundwater samples during geoprobe sampling at AOC 681. Dibenzofuran was detected at 3.0 μg/L in 681GP002, which exceeds the tap water RBC of

2.4 μg/L. Phenol and 2,4-dimethylphenol were detected in deep grid-based well GDI13D, however, neither exceeded its RBC.

Other Organic Compounds in Groundwater

Geoprobe samples collected at AOC 681 were only analyzed for VOCs and SVOCs. No other organics were detected in samples collected from monitoring wells installed at AOC 681 or from grid-based wells GDI013 and GDI13D.

Inorganics in Groundwater

Thirteen metals were detected in shallow groundwater samples collected from AOC 681 monitoring wells. None of these detections exceeded the tap water RBC or MCL and shallow background. Fourteen metals were detected in the grid-based well pair (GDI013, GDI13D) adjacent to AOC 681, however, none of these exceeded their respective tap water RBC or MCL and background.

Geoprobe groundwater samples were not analyzed for inorganics.

10.6.3 Wipe Sampling and Analysis

Seven wipe samples, to be submitted for lead and aluminum compound analyses, were proposed in the *Final Zone I RFI Work Plan* (E/A&H, February 1995). Eight samples collected from horizontal surfaces inside Building 681 and near the blast booth were submitted for lead and aluminum analyses. Table 10.6.9 summarizes the wipe sampling at AOC 681.

Table 10.6.9
AOC 681
Wipe Sampling Summary

Samples Proposed	Samples Collected	Analyses Proposed	Analyses Performed	Deviations
7	8	Lead and aluminum compounds	Lead and aluminum compounds	An additional sample was collected to further characterize the site.

10.6.4 Nature and Extent of Contamination in Dust

Table 10.6.10 summarizes the wipe sampling analytical results.

Table 10.6.10
AOC 681
Wipe Sampling Analytical Results (μg/wipe)

Frequency of Detections	Parameter	Range of Detections
7/8	Lead	52 - 1,310
8/8	Aluminum compounds	30 - 19,200

Lead in Dust

Seven of eight samples had detections of lead ranging from 52 μg/wipe to 1,310 μg/wipe.

Aluminum and Compounds in Dust

All eight samples had detections of aluminum and compounds ranging from 30 μg/wipe to 19,200 μg/wipe.

10.6.5 Fate and Transport Assessment

AOC 681 is the blast booth in Building 681, which houses a stripping operation where various surface coating materials are removed. Building 681 was constructed in 1985 to serve as a shop and administration building for Shore Intermediate Maintenance Activity (SIMA). The facility contained a hose shop; a canvas shop; a tool storage area; a valve shop; a lagging shop; an air conditioning and recovery shop; a hydraulics shop; a paint booth; a blasting booth; a pump shop; a machine shop; an electrical shop; and a varnish dip tank. The facility is currently used as a vessel support facility for the U.S. Coast Guard. Currently, the site is paved, which limits the migration pathways of rainwater infiltration and surface soil runoff.

Environmental media sampled as part of the AOC 681 investigation include surface soil, subsurface soil, shallow groundwater and deep groundwater. Potential constituent migration pathways investigated include soil to groundwater, groundwater migration, and emission of volatiles from surface soil to air. Additionally, an effort to preliminarily address the issue of discharge to surface water receptors was made. This assessment is intended to serve as a qualitative analysis using the analytical data for these media coupled with the current understanding of hydrogeological conditions at the site.

10.6.5.1 Soil to Groundwater Cross-Media Transport

Tables 10.6.11 and 10.6.12 compare maximum detected organic and inorganic constituent concentrations in surface soil and subsurface soil samples respectively to risk-based soil screening levels considered protective of groundwater. To provide a conservative screen, generic soil screening levels are used; leachate entering the aquifer is assumed to be diluted by a ratio of 10:1, with no attenuation of constituents in soil (DAF = 10).

Two semi-volatile organic compounds — acetophenone and BEQs — were present in soil above their respective screening values. Acetophenone was only detected in one of six subsurface soil samples and was not detected in any surface soil samples. There were no corresponding detections of this compound in the groundwater samples indicating that this lone detection may be an anomaly and the soil-to-groundwater pathway for this compound is not considered valid. BEQs were detected in both the surface and subsurface soil samples in an area between Buildings 680 and 681. However, there were no detections of BEQs in the shallow groundwater samples at the site. The absence of any BEQs in the shallow groundwater in this area indicates that the pathway may not be valid. Figure 10.6.2 presents BEQ concentrations detected at AOC 681.

One pesticide — dieldrin — was present in surface and subsurface soil samples above its screening value. The distribution of this pesticide was spatially limited, occurring in only three of eleven surface soil samples and only one of six subsurface samples. There were no detections of this pesticide in the groundwater samples indicating the pathway is not likely to be valid. Figure 10.6.3 presents the dieldrin concentrations detected at AOC 681.

Table 10.6.11
Organic Chemicals Detected in Surface Soil, Subsurface Soil, Sediment, and Shallow Groundwater
Comparison to Cross-media SSLs, Tap Water RBCs, and Saltwater Surface Water Chronic Screening Levels
AOC 681
Charles Naval Complex
Charleston, South Carolina

Parameter	Maximum Concentration Surface Soil	Subsurface Soil	Sediment	Shallow GW	Screening Concentration Soil to GW SSL	Soil to Air SSL	Tap Water RBC	Saltwater Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Volatilization Potential	Ground-water Migration Concern	Surface Water Migration Concern
Volatile Organic Compounds														
Acetone	48	54	NA	9.9	8000	1.0E+08	3700	NA	UG/KG	UG/L	NO	NO	NO	NO
Carbon disulfide	ND	1	NA	2	16000	720000	1000	NA	UG/KG	UG/L	NO	NO	NO	NO
Toluene	2	2	NA	ND	6000	650000	750	37	UG/KG	UG/L	NO	NO	NO	NO
Xylene (total)	3.3	3.6	NA	ND	70000 a	410000	12000	NA	UG/KG	UG/L	NO	NO	NO	NO
Semivolatile Organic Compounds														
Acenaphthene	140	3800	NA	53	290000	NA	2200	9.7	UG/KG	UG/L	NO	NO	NO	YES
Acetophenone	ND	41	NA	ND	0.12 a	NA	0.042	NA	UG/KG	UG/L	YES	NO	NO	NO
Anthracene	640	4900	NA	ND	5900000	NA	11000	NA	UG/KG	UG/L	NO	NO	NO	NO
Benzo(g,h,i)perylene	850	3800	NA	ND	1.2E+08 a	NA	1500	NA	UG/KG	UG/L	NO	NO	NO	NO
Benzo(a)pyrene Equivalents	3445	16783	NA	ND	1600 a	NA	0.0092	NA	UG/KG	UG/L	YES	NO	NO	NO
Benzo(a)anthracene c	2900	18000	NA	ND	800	NA	0.092	NA	UG/KG	UG/L	YES	NO	NO	NO
Benzo(a)pyrene c	2300	11000	NA	ND	4000	NA	0.0092	NA	UG/KG	UG/L	YES	NO	NO	NO
Benzo(b)fluoranthene c	2700	20000	NA	ND	2500	NA	0.092	NA	UG/KG	UG/L	YES	NO	NO	NO
Benzo(k)fluoranthene c	2400	22000	NA	ND	25000	NA	0.92	NA	UG/KG	UG/L	NO	NO	NO	NO
Chrysene c	3200	13000	NA	ND	80000	NA	9.2	NA	UG/KG	UG/L	NO	NO	NO	NO
Dibenz(a,h)anthracene c	470	1300	NA	ND	800	NA	0.0092	NA	UG/KG	UG/L	YES	NO	NO	NO
Indeno(1,2,3-cd)pyrene c	880	4500	NA	ND	7000	NA	0.092	NA	UG/KG	UG/L	NO	NO	NO	NO
Butylbenzylphthalate	180	ND	NA	ND	930000	930000	7300	29.4	UG/KG	UG/L	NO	NO	NO	NO
Dibenzofuran	54	2000	NA	13	6800 a	120000	24	NA	UG/KG	UG/L	NO	NO	NO	NO
Di-n-butylphthalate	100	65	NA	ND	2300000	2300000	3700	3.4	UG/KG	UG/L	NO	NO	NO	NO
Di-n-octyl phthalate	30	ND	NA	ND	10000000	10000000	730	NA	UG/KG	UG/L	NO	NO	NO	NO
bis(2-Ethylhexyl)phthalate (BEHP) c	750	110	NA	22	1800000	31000000	4.8	NA	UG/KG	UG/L	NO	NO	YES	NO
Fluoranthene	7500	19000	NA	ND	2100000	NA	1500	1.6	UG/KG	UG/L	NO	NO	NO	NO
Fluorene	180	3800	NA	10	280000	NA	1500	NA	UG/KG	UG/L	NO	NO	NO	NO
1-Methylnaphthalene	44	620	NA	ND	72000 a	NA	1500	NA	UG/KG	UG/L	NO	NO	NO	NO
2-Methylnaphthalene	ND	490	NA	ND	230000 a	NA	1500	23.5	UG/KG	UG/L	NO	NO	NO	NO
Naphthalene	ND	1500	NA	0.57	42000	NA	1500	23.5	UG/KG	UG/L	NO	NO	NO	NO
3-Nitroaniline	ND	250	NA	ND	270 a	NA	110	NA	UG/KG	UG/L	NO	NO	NO	NO
Phenanthrene	3300	15000	NA	1.3	660000 a	NA	1100	NA	UG/KG	UG/L	NO	NO	NO	NO
Pyrene	5600	18000	NA	ND	2100000	NA	1100	NA	UG/KG	UG/L	NO	NO	NO	NO
Pesticides/PCBs														
Aldrin c	ND	15	NA	ND	230	3000	0.0039	0.13	UG/KG	UG/L	NO	NO	NO	NO
Aroclor-1254 c	190	ND	NA	ND	1000	1000	0.033	0.03	UG/KG	UG/L	NO	NO	NO	NO
beta-BHC (beta-HCH) c	1	ND	NA	ND	1.3	1E+09	0.037	NA	UG/KG	UG/L	NO	NO	NO	NO
gamma-BHC (Lindane) c	1.1	ND	NA	ND	4.5	NA	0.052	0.016	UG/KG	UG/L	NO	NO	NO	NO

Table 10.6.11
Organic Chemicals Detected in Surface Soil, Subsurface Soil, Sediment, and Shallow Groundwater
Comparison to Cross-media SSLs, Tap Water RBCs, and Saltwater Surface Water Chronic Screening Levels
AOC 681
Charles Naval Complex
Charleston, South Carolina

Parameter	Maximum Concentration				Screening Concentration									
	Surface Soil	Subsurface Soil	Sediment	Shallow GW	Soil to GW SSL	Soil to Air SSL	Tap Water RBC	Saltwater Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Volatilization Potential	Ground-water Migration Concern	Surface Water Migration Concern
Pesticides/PCBs (continued)														
Chlordane c	120	ND	NA	ND	5000	20000	0.19	0.004	UG/KG	UG/L	NO	NO	NO	NO
alpha-Chlordane c	28	2.4	NA	ND	5000 b	20000	0.19	0.004	UG/KG	UG/L	NO	NO	NO	NO
gamma-Chlordane c	33	5.6	NA	ND	5000 b	20000	0.19	0.004	UG/KG	UG/L	NO	NO	NO	NO
Dieldrin c	6.5	13	NA	ND	2	1000	0.0042	0.0019	UG/KG	UG/L	YES	NO	NO	NO
Endosulfan I	ND	32	NA	ND	9000 b	NA	220	0.0087	UG/KG	UG/L	NO	NO	NO	NO
Endosulfan II	3.6	ND	NA	ND	9000 b	NA	220	0.0087	UG/KG	UG/L	NO	NO	NO	NO
Endosulfan sulfate	1.9	ND	NA	ND	4600 a	NA	220	NA	UG/KG	UG/L	NO	NO	NO	NO
Endrin	0.62	ND	NA	ND	500	NA	11	0.0023	UG/KG	UG/L	NO	NO	NO	NO
Heptachlor c	94	3.3	NA	ND	11000	100	0.0023	0.0036	UG/KG	UG/L	NO	NO	NO	NO
Heptachlor epoxide c	22	ND	NA	ND	330	5000	0.0012	0.0036	UG/KG	UG/L	NO	NO	NO	NO
Methoxychlor	ND	68	NA	ND	80000	NA	180	0.03	UG/KG	UG/L	NO	NO	NO	NO
Herbicides														
2,4,5-TP (Silvex)	0.1	ND	NA	ND	5600 a	NA	290	NA	UG/KG	UG/L	NO	NO	NO	NO
TPH-DRO														
TPH - Diesel range organics	150	ND	NA	ND	NA	NA	NA	NA	UG/KG	UG/L	NO	NO	NO	NO
Dioxin Compounds														
2,3,7,8-TCDD equivalents (TEQs) c	0.325	NA	NA	NA	1600 a	NA	0.45	10	NG/KG	PG/L	NO	NO	NO	NO
1234678-HpCDD c	14.1	NA	NA	NA	108000 a	NA	45	NA	NG/KG	PG/L	NO	NO	NO	NO
OCDD c	124.3	NA	NA	NA	1080000 a	NA	450	NA	NG/KG	PG/L	NO	NO	NO	NO
1234678-HpCDF c	4.9	NA	NA	NA	54000 a	NA	45	NA	NG/KG	PG/L	NO	NO	NO	NO
OCDF c	10.1	NA	NA	NA	540000 a	NA	450	NA	NG/KG	PG/L	NO	NO	NO	NO

Notes:
Sources of screening concentrations appear in Table 5.5
Explanations of fate and transport screening procedures appear in Section 6.2.
Frequency and range of detections, average detected concentrations, and number of screening concentration exceedances appear in Tables 10.6.2, 10.6.6, 10.6.7, and 10.6.8.

a - Calculated soil to groundwater SSL value (See Table 6.2)
b - Based on surrogate compound; see Table 5.5
c - Carcinogenic
GW - Groundwater

NA - Not applicable/not available
ND - Not detected
RBC - Risk-based concentration
SSL - Soil screening level

NG/KG - Nanograms per kilogram
UG/KG - Micrograms per kilogram
PG/L - Picograms per liter
UG/L - Micrograms per liter

Table 10.6.12
Inorganic Chemicals Detected in Surface Soil, Subsurface Soil, Sediment, and Shallow Groundwater
Comparison to Cross-media SSLs, Tap Water RBCs, Saltwater Surface Water Chronic Screening Levels, and Background Values
AOC 681
Charleston Naval Complex
Charleston, South Carolina

Parameter	Maximum Concentration Surface Soil	Subsurface Soil	Sediment	Shallow GW	Screening Concentration Soil to GW SSL	Soil Background	Soil to Air SSL	Tap Water RBC	Shallow GW Background	Saltwater Surf. Wtr Chronic	Soil Units	Water Units	Leaching Potential	Fugitive Particulate Inhalation Concern	Ground-water Migration Concern	Surface Water Migration Concern
Inorganic Chemicals																
Aluminum (Al)	11900	11400	NA	131	560000 a	27400	NA	37000	1440	NA	MG/KG	UG/L	NO	NO	NO	NO
Antimony (Sb)	2.3	ND	NA	ND	2.7	ND	NA	15	NA	NA	MG/KG	UG/L	NO	NO	NO	NO
Arsenic (As) c	6.6	5.7	NA	8.1	15	21.6	750	0.045	23	36	MG/KG	UG/L	NO	NO	NO	NO
Barium (Ba)	34.5	18.4	NA	53.6	820	54.2	690000	2600	110	NA	MG/KG	UG/L	NO	NO	NO	NO
Beryllium (Be)	0.6	0.3	NA	ND	32	0.95	1300	73	1.1	NA	MG/KG	UG/L	NO	NO	NO	NO
Cadmium (Cd)	2.4	0.4	NA	ND	4	0.61	1800	18	NA	9.3	MG/KG	UG/L	NO	NO	NO	NO
Chromium (Cr) (total)	79.2	41.1	NA	ND	19	51.3	270	180	14.3	50	MG/KG	UG/L	YES	NO	NO	NO
Cobalt (Co)	26.9	1.8	NA	1.7	990 a	5.8	NA	2200	2.2	NA	MG/KG	UG/L	NO	NO	NO	NO
Copper (Cu)	37.2	28.2	NA	10.1	5600 a	240	NA	1500	4.4	2.9	MG/KG	UG/L	NO	NO	NO	YES
Lead (Pb)	39.2	71.6	NA	3.3	400	203	400	15	4.4	8.5	MG/KG	UG/L	NO	NO	NO	NO
Manganese (Mn)	250	83.1	NA	89.1	480 a	419	NA	730	5430	NA	MG/KG	UG/L	NO	NO	NO	NO
Mercury (Hg)	0.19	0.07	NA	0.19	1	0.47	10	11	NA	0.025	MG/KG	UG/L	NO	NO	NO	YES
Nickel (Ni)	32.4	14.5	NA	2.3	65	23.9	13000	730	13.3	8.3	MG/KG	UG/L	NO	NO	NO	NO
Selenium (Se)	1	1.1	NA	2.9	2.6	1.77	NA	180	ND	71	MG/KG	UG/L	NO	NO	NO	NO
Silver (Ag)	ND	ND	NA	6.1	17	NA	NA	180	NA	0.23	MG/KG	UG/L	NO	NO	NO	YES
Thallium (Tl)	ND	ND	NA	2.4	0.36	ND	NA	2.6	2	21.3	MG/KG	UG/L	NO	NO	NO	NO
Tin (Sn)	1.6	2.1	NA	ND	5500 a	7.5	NA	22000	NA	NA	MG/KG	UG/L	NO	NO	NO	NO
Vanadium (V)	22.9	31.7	NA	9.6	3000	113	NA	260	14	NA	MG/KG	UG/L	NO	NO	NO	NO
Zinc (Zn)	213	59.2	NA	13.6	6200	206	NA	11000	24.4	86	MG/KG	UG/L	NO	NO	NO	NO

Notes:
Sources of screening concentrations appear in Table 5.6
Explanations of fate and transport screening procedures appear in Section 6.2.
Frequency and range of detections, average detected concentrations, and number of screening concentration exceedances appear in Tables 10.6.3 and 10.6.6.

Background values for soil are shown for comparison purposes only.
Maximum groundwater concentrations are screened against the greater of tap water RBCs or corresponding background values to determine groundwater migration concern.

a - Calculated soil to groundwater SSL value (See Table 6.2)
c - Carcinogenic
GW - Groundwater

NA - Not available/Not applicable
ND - Not detected
RBC - Risk-based concentration

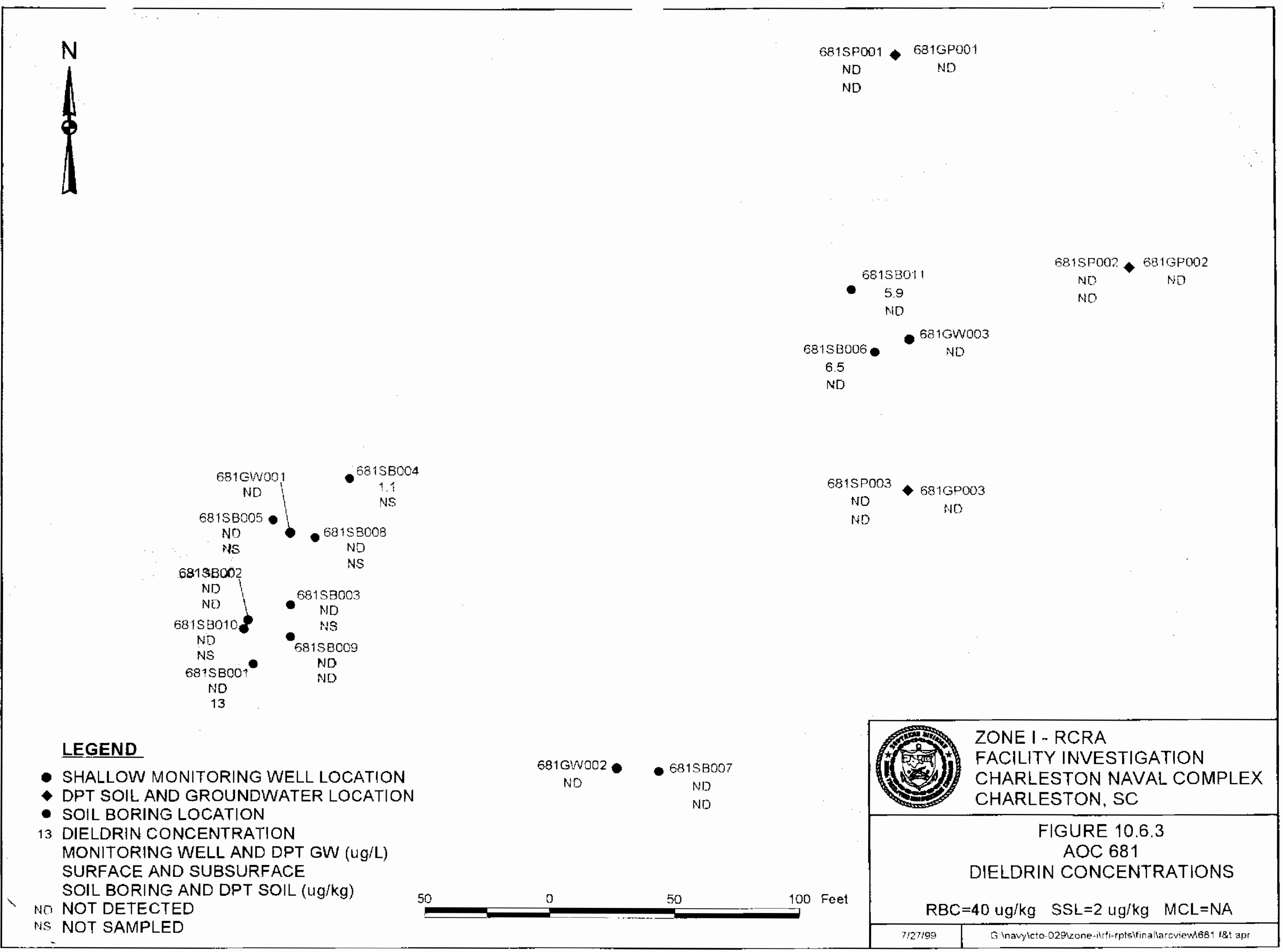
SSL - Soil screening level
MG/KG - Milligrams per kilogram
UG/L - Micrograms per liter

One inorganic — chromium — was present in soil above its screening value. It was present in both surface and subsurface soil samples. It was only detected in groundwater in the grid-base well location (both shallow and deep samples). Figure 10.6.4 presents the chromium concentrations detected at AOC 681. The presence of chromium in soil is potentially consistent with past activities at Buildings 680 and 681 (maintenance shop) and the presence of chromium in soil and groundwater validates the pathway with respect to this parameter.

10.6.5.2 Groundwater Migration to Surface Water Cross Media Transport

Tables 10.6.11 and 10.6.12 compare maximum detected organic and inorganic constituent concentrations respectively, in shallow groundwater to risk-based concentrations for drinking water, and to chronic ambient saltwater quality criteria values for the protection of aquatic life (saltwater surface water chronic screening values). For inorganics, maximum concentrations in groundwater are screened against the greater of (a) risk-based drinking water concentrations or (b) corresponding background concentrations for groundwater, as well as to the saltwater surface water chronic values. To provide a conservative screening, no attenuation or dilution of constituents in groundwater is assumed before comparison to the relevant standards. It should be noted at the beginning of this discussion that the risk-based pathway for shallow groundwater is currently an invalid pathway simply because there is no human consumption of the groundwater, e.g. there is no end-use receptor. This comparison is made for screening only, and to develop strategies for long-term management of the groundwater should an area containing deleterious levels be identified.

Two semi-volatile compounds — acenaphthene and bis(2-ethylhexly)phathalate (BEHP) were present in groundwater at concentrations that exceeded their respective screening values. Both exhibited only slight exceedances. Acenaphthene was only detected in one geoprobe sample and BEHP was only detected above the screening value in one well in the second round. The inconsistent detections of acenaphthene would indicate that the pathway is not considered valid



ZONE I - RCRA
FACILITY INVESTIGATION
CHARLESTON NAVAL COMPLEX
CHARLESTON, SC

FIGURE 10.6.3
AOC 681
DIELDRIN CONCENTRATIONS

RBC=40 ug/kg SSL=2 ug/kg MCL=NA

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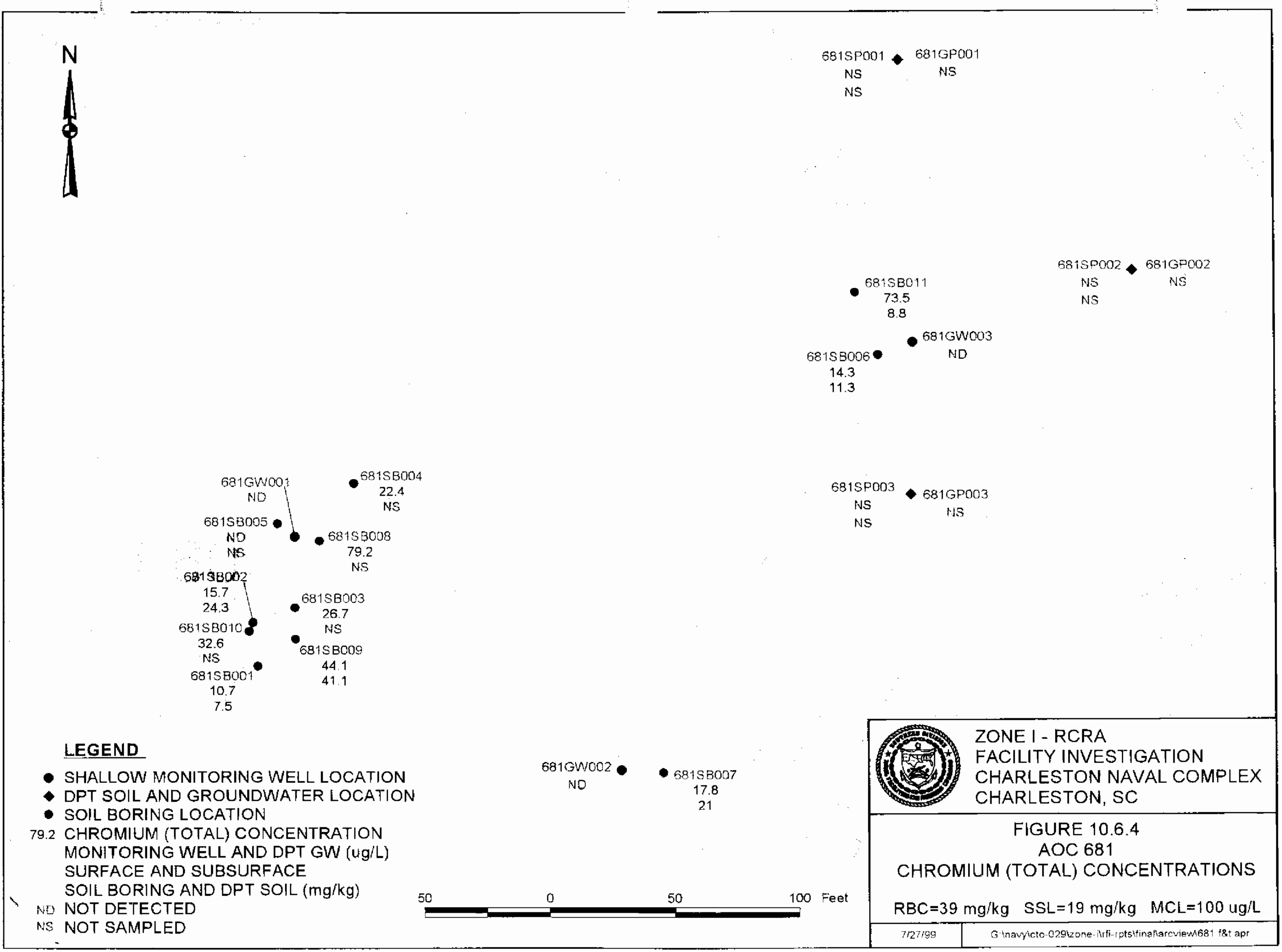

N
681SP001
NS
NS
681GP001
NS
681SP002
NS
NS
681GP002
NS
681SB011
73.5
8.8
681GW003
ND
681SB006
14.3
11.3
681SP003
NS
NS
681GP003
NS
681GW001
ND
681SB004
22.4
NS
681SB005
ND
NS
681SB008
79.2
NS
681SB002
15.7
24.3
681SB003
26.7
NS
681SB010
32.6
NS
681SB009
44.1
41.1
681SB001
10.7
7.5
681GW002
ND
681SB007
17.8
21
LEGEND
SHALLOW MONITORING WELL LOCATION
DPT SOIL AND GROUNDWATER LOCATION
SOIL BORING LOCATION
79.2 CHROMIUM (TOTAL) CONCENTRATION
MONITORING WELL AND DPT GW (ug/L)
SURFACE AND SUBSURFACE
SOIL BORING AND DPT SOIL (mg/kg)
ND NOT DETECTED
NS NOT SAMPLED
50 0 50 100 Feet
ZONE I - RCRA
FACILITY INVESTIGATION
CHARLESTON NAVAL COMPLEX
CHARLESTON, SC
FIGURE 10.6.4
AOC 681
CHROMIUM (TOTAL) CONCENTRATIONS
RBC=39 mg/kg SSL=19 mg/kg MCL=100 ug/L
7/27/99
G:\navy\cto-029\zone-i\rfi-rpts\final\arcview\681 f&t.apr

with respect to this constituent. The presence of BEHP is suspect (it is often a common laboratory artifact) and due to its absence in the most recent round of groundwater sampling as well as its absence from groundwater samples collected from the grid-based shallow well, the pathway for this constituent is considered invalid. Figure 10.6.5 presents concentrations of BEHP detected at AOC 681.

Three inorganic constituents — copper, mercury, and silver — were present in groundwater at levels above their respective screening values for surface water migration. Copper was detected at approximately twice its background for shallow groundwater, but was not above its SSL in surface or subsurface soil. Figure 10.6.6 presents concentrations of copper detected at AOC 681. Mercury was detected above its screening value for surface water migration but was only detected in the third round of sampling and was not detected in the grid-based well. Mercury detections were also below SSLs for surface and subsurface soil. Silver was only detected in one well in the first and third round of sampling and was not detected in the grid-based well. Additionally, silver was not detected in the soil samples collected at this site. The proximity of the Cooper River and the groundwater flow direction indicate that the river is a potential receptor of groundwater discharge, but attenuation along the flowpath and dilution upon discharge to the river will likely reduce concentrations of these constituents to insignificant levels.

10.6.5.3 Soil to Air Cross-Media Transport

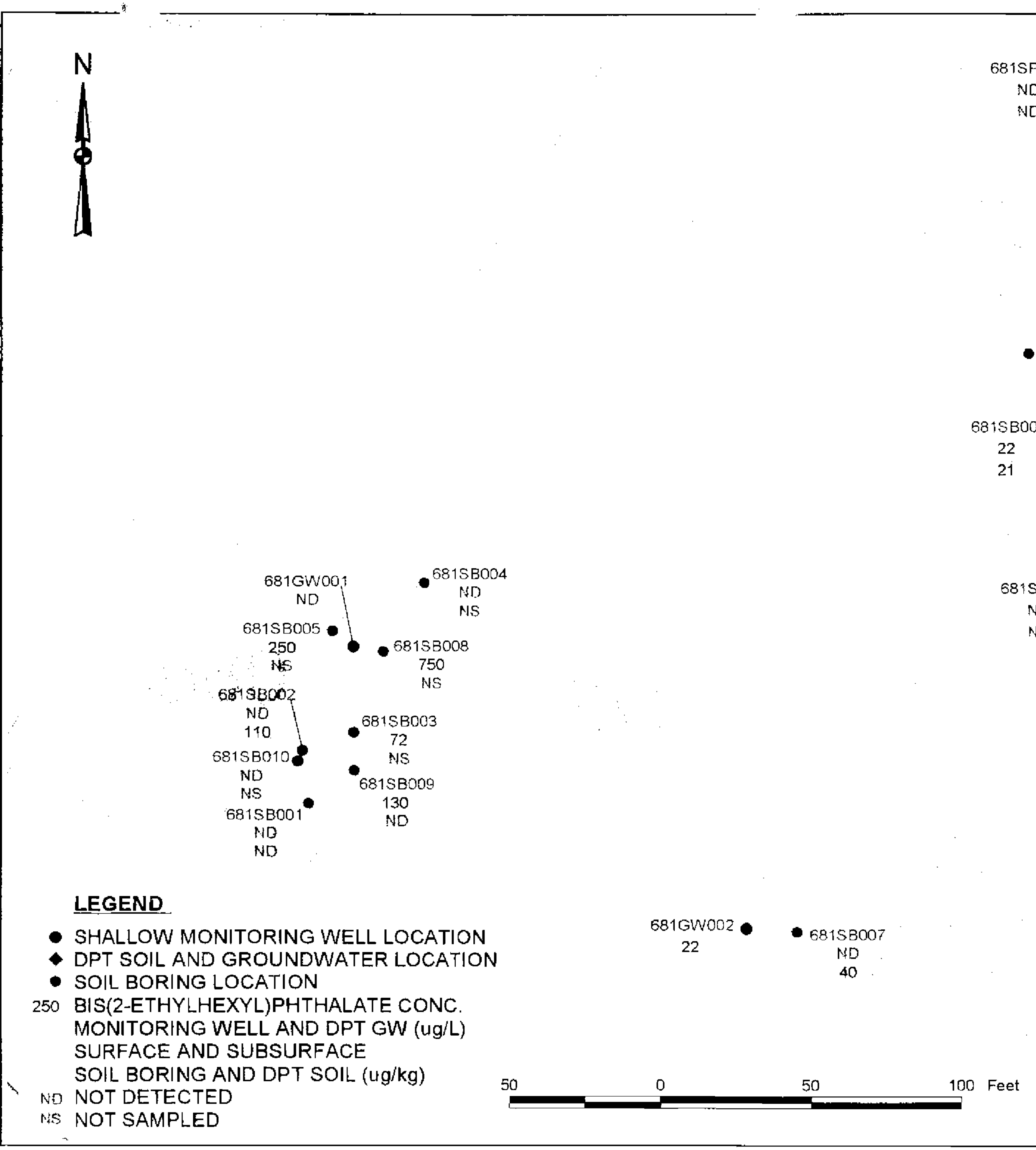
No surface soil parameters were present above their respective screening values for the soil to air pathway, thus the pathway is considered invalid for this AOC.

10.6.5.4 Fate and Transport Summary

Acetophenone and BEQs were present in soil above their respective SSLs. Acetophenone was only detected in one of six subsurface soil samples and was not detected in any surface soil samples. There were no corresponding detections of this compound in the groundwater samples indicating that this lone detection may be an anomaly and the soil-to-groundwater pathway for this compound is not considered valid. BEQs were detected in both the surface and subsurface soil samples in an area between Buildings 680 and 681. However, there were no detections of BEQs in the shallow groundwater samples at the site. The absence of any BEQs in the shallow groundwater in this area indicates that the pathway may not be valid.

Acenaphthene and BEHP were present in groundwater at concentrations that exceeded their respective screening values. Both exhibited only slight exceedances. Acenaphthene was only detected in one geoprobe sample and BEHP was only detected above the screening value in one well in the second round. The inconsistent detections and the fact that these constituents were not detected in the most recent sampling round would invalidate the pathway.

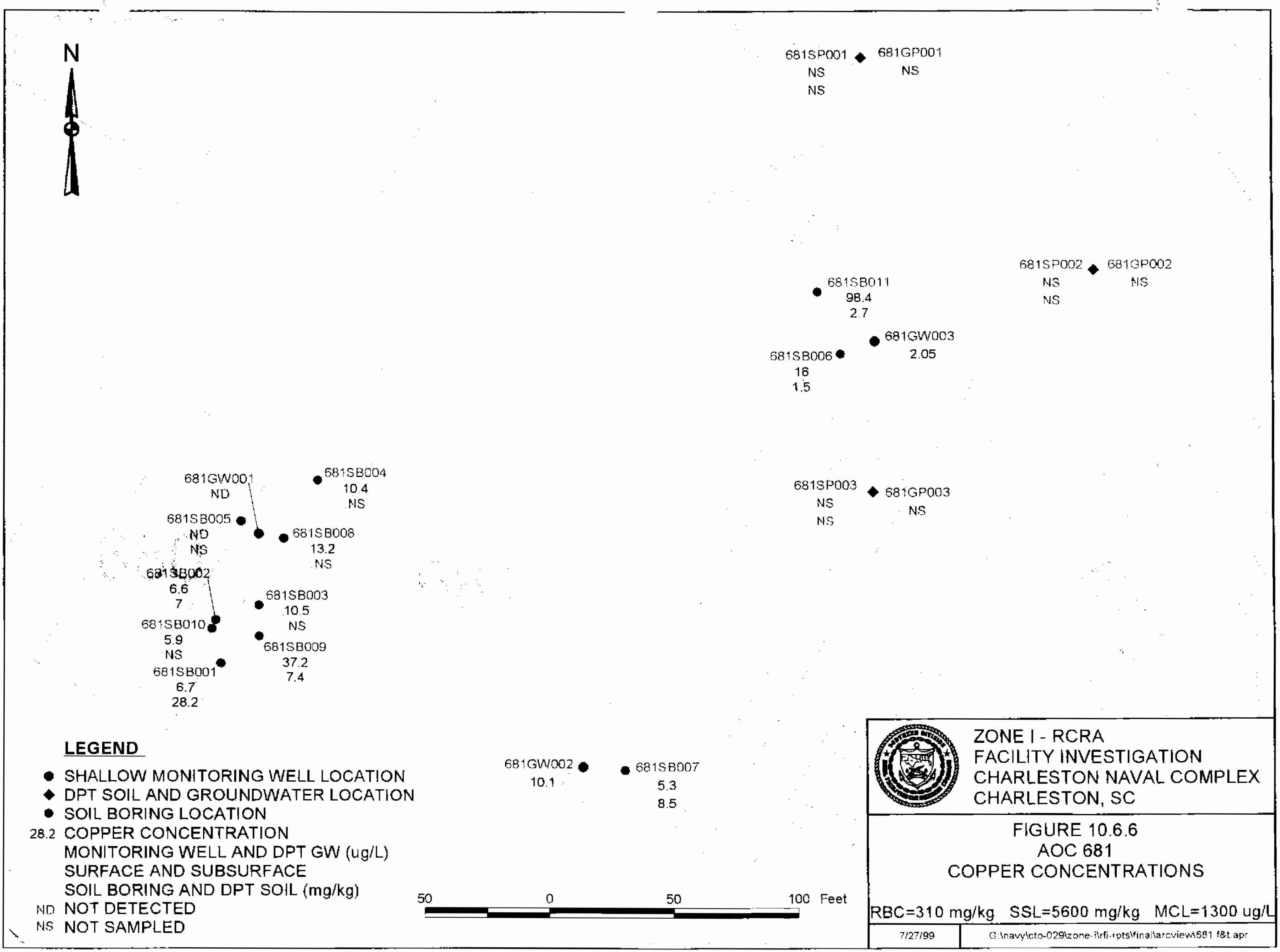
Copper, mercury, and silver were present in groundwater at levels above their respective screening values for surface water migration. Copper was detected at approximately twice its background for shallow groundwater, but was not above its SSL in surface or subsurface soil. Mercury was detected above its screening value for surface water migration but was only detected in the third round of sampling and was not detected in the grid-based well. Mercury detections were also below SSLs for surface and subsurface soil. Silver was only detected in one well in the first and third round of sampling and was not detected in the grid-based well. Additionally, silver was not detected in the soil samples collected at this site. The proximity of the Cooper River and the groundwater flow direction indicate that the river is a potential receptor of groundwater discharge, but attenuation along the flowpath and dilution upon discharge to the river will likely reduce concentrations of these constituents to insignificant levels.



ZONE I - RCRA
FACILITY INVESTIGATION
CHARLESTON NAVAL COMPLEX
CHARLESTON, SC

FIGURE 10.6.5
AOC 681
BIS(2-ETHYLHEXYL)PHTHALATE
CONCENTRATIONS
RBC=4.6E4 ug/kg SSL=1.8E6 ug/kg MCL=NA

7/27/99	G:\navy\cto-029\zone-i\rfi-rpts\final\arcview\681 f&t apr



N
681SP001
NS
NS
681GP001
NS
681SP002
NS
NS
681GP002
NS
681SB011
98.4
2.7
681GW003
2.05
681SB006
16
1.5
681GW001
ND
681SB004
10.4
NS
681SB005
ND
NS
681SB008
13.2
NS
681SP003
NS
NS
681GP003
NS
681SB002
6.6
7
681SB003
10.5
NS
681SB010
5.9
NS
681SB009
37.2
7.4
681SB001
6.7
28.2
681GW002
10.1
681SB007
5.3
8.5
LEGEND
SHALLOW MONITORING WELL LOCATION
DPT SOIL AND GROUNDWATER LOCATION
SOIL BORING LOCATION
28.2 COPPER CONCENTRATION
MONITORING WELL AND DPT GW (ug/L)
SURFACE AND SUBSURFACE
SOIL BORING AND DPT SOIL (mg/kg)
ND NOT DETECTED
NS NOT SAMPLED
50 0 50 100 Feet
ZONE I - RCRA
FACILITY INVESTIGATION
CHARLESTON NAVAL COMPLEX
CHARLESTON, SC
FIGURE 10.6.6
AOC 681
COPPER CONCENTRATIONS
RBC=310 mg/kg SSL=5600 mg/kg MCL=1300 ug/L
7/27/99
G:\navy\cto-029\zone-i\rfi-rpts\final\arcview\681 f&t.apr

10.6.6. Human Health Risk Assessment for AOC 681

10.6.6.1 Site Background and Investigative Approach

The purpose of the investigation at AOC 681 was to assess contamination in soil and groundwater and on interior surfaces of Building 681. AOC 681 is a blast booth in Building 681 used to strip paint from miscellaneous components.

Building 681 was constructed in 1985 to serve as a shop and administration building for Shore Intermediate Maintenance Activity (SIMA). The facility contained a hose shop; a canvas shop; a tool storage area; a valve shop; a lagging shop; an air conditioning and recovery shop; a hydraulics shop; a paint booth; a blasting booth; a pump shop; a machine shop; an electrical shop; and a varnish dip tank. The facility is currently used as a vessel support facility for the U.S. Coast Guard.

Two underground storage tanks (681-1 and 681-2) were associated with this facility. The tanks were installed in 1985, when the facility was constructed. Both tanks were closed by removal in early 1997.

Building 680, which is located on the west side of Building 681, was constructed in 1975 and is used for maintenance activities similar to those conducted in Building 681. Engine parts and other equipment are cleaned in dip tanks and/or are sandblasted clean as part of repair and maintenance programs.

A total of eleven surface soil samples were collected at the AOC 681 area. The number of soil samples differs for various groups of analytes because specific groups were targeted at certain sample locations and/or sampling rounds. In addition, soil samples were collected from three DPT locations in the northeastern quadrant of the site. The Navy's Environmental Detachment also collected six shallow soil samples, both inside and outside Building 681 in the vicinity of boring 681SB009. These sample results are not used in the HHRA as they do not meet DQOs.

However, the results of all sampling are discussed in the Nature and Extent of Contamination section.

Groundwater was sampled in three rounds from three monitoring wells installed at AOC 681.

Seven wipe samples were also collected from interior surfaces in and around the Building 681 blast booth. These samples were analyzed for lead and aluminum oxides. The analyses were semi-quantitative in that the wipe area was not precisely measured for each sample. The intent of the sampling effort was to confirm or refute the presence of lead and aluminum oxides on interior surfaces. AOC 681 is located within an area slated to become part of a marine cargo terminal in current base reuse plans. As a result, if Building 681 is maintained in its current condition under reuse plans, potential receptors will be limited to adults engaged in occupational activities.

Lead data are discussed in the following sections, but no formal quantitative risk assessment was attempted for wipe sample data. The results of wipe samples were summarized in Section 10.6.4.

10.6.6.2 COPC Identification

Soil

Based on the screening comparisons described in Section 7 of this RFI and presented in Table 10.6.13, benzo(a)pyrene equivalents and chromium were the surface soil COPCs identified. Aluminum, arsenic, and manganese were detected at maximum concentrations exceeding their RBCs but not exceeding their respective background concentrations. Therefore, these inorganics were eliminated from further consideration in the HHRA. No additional COPCs were identified based on the results of Wilcoxon rank sum test analyses.

Table 10.6.13
Chemicals Present in Site Samples
AOC 681 - Surface Soil
Charleston Naval Complex
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration Residential RBC	Screening Concentration Background	Units	Number Exceeding RBC	Number Exceeding Background
Carcinogenic PAHs													
Benzo(a)pyrene Equivalents	*	4	11	69.2	3445	945	830	930	87	NA	UG/KG	3	
Benzo(a)anthracene	*	4	11	60	2900	784	370	770	870	NA	UG/KG	1	
Benzo(a)pyrene	*	4	11	51	2300	640	370	770	87	NA	UG/KG	2	
Benzo(b)fluoranthene	*	4	11	110	2700	793	370	900	870	NA	UG/KG	1	
Benzo(k)fluoranthene		4	11	120	2400	733	370	720	8700	NA	UG/KG		
Chrysene		4	11	48	3200	863	370	630	87000	NA	UG/KG		
Dibenz (a,h) anthracene	*	1	11	470	470	470	370	520	87	NA	UG/KG	1	
Indeno(1,2,3-cd)pyrene	*	1	11	880	880	880	370	560	870	NA	UG/KG	1	
Inorganics													
Aluminum (Al)		10	10	3870	11900	6092	NA	NA	7800	27400	MG/KG	3	
Antimony (Sb)		2	10	0.23	2.3	1.27	0.21	2.5	3.1	ND	MG/KG		
Arsenic (As)		8	10	1.4	6.6	3.58	2	3.5	0.43	21.6	MG/KG	8	
Barium (Ba)		10	10	9.1	34.5	17.8	NA	NA	550	54.2	MG/KG		
Beryllium (Be)		7	10	0.15	0.63	0.3	0.14	0.26	16	0.95	MG/KG		
Cadmium (Cd)		9	10	0.12	2.4	0.64	0.17	0.21	7.8	0.61	MG/KG		3
Calcium (Ca)	N	10	10	4980	211000	100683	NA	NA	NA	NA	MG/KG		
Chromium (Cr)	*	10	10	10.7	79.2	33.7	NA	NA	39	34.5	MG/KG	3	3
Cobalt (Co)		10	10	0.97	26.9	7.45	NA	NA	470	5.8	MG/KG		3
Copper (Cu)		10	10	5.3	98.4	21.02	NA	NA	310	240	MG/KG		
Iron (Fe)	N	10	10	3000	32400	7036	NA	NA	NA	NA	MG/KG		
Lead (Pb)		10	10	4.2	39.2	17	NA	NA	400	203	MG/KG		
Magnesium (Mg)	N	10	10	482	8720	2862	NA	NA	NA	NA	MG/KG		
Manganese (Mn)		10	10	23.4	250	105	NA	NA	160	419	MG/KG	3	
Mercury (Hg)		4	10	0.06	0.19	0.1	0.03	0.12	2.3	0.47	MG/KG		
Nickel (Ni)		10	10	5.3	32.4	13	NA	NA	160	23.9	MG/KG		2
Potassium (K)	N	8	10	214	1790	765	311	441	NA	NA	MG/KG		
Selenium (Se)		5	10	0.42	1	0.68	0.15	0.49	39	1.49	MG/KG		
Sodium (Na)	N	6	10	59.3	775	520	113	470	NA	NA	MG/KG		
Tin (Sn)		1	10	1.6	1.6	1.6	0.88	100	4700	7.5	MG/KG		
Vanadium (V)		9	10	8.4	44.1	18.6	19.9	19.9	55	113	MG/KG		
Zinc (Zn)		10	10	20.1	213	55.6	NA	NA	2300	206	MG/KG		1

Table 10.6.13
Chemicals Present in Site Samples
AOC 681 - Surface Soil
Charleston Naval Complex
Charleston, South Carolina

Parameter	Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration Residential RBC	Screening Concentration Background	Units	Number Exceeding RBC	Number Exceeding Background
Pesticides/PCBs												
Aroclor 1254	1	11	190	190	190	12	110	320	NA	UG/KG		
beta-BHC	1	11	1	1	1	0.58	5.6	350	NA	UG/KG		
Chlordane	4	5	24	120	71	2.3	2.3	1800	NA	UG/KG		
Dieldrin	3	11	1.1	6.5	4.5	0.9	8.4	40	NA	UG/KG		
Endosulfan II	1	11	3.6	3.6	3.6	2	20	47000	NA	UG/KG		
Endosulfan sulfate	1	11	1.9	1.9	1.9	1.2	11	47000	NA	UG/KG		
Endrin	1	11	0.62	0.62	0.62	1.4	14	2300	NA	UG/KG		
gamma-BHC (Lindane)	1	11	1.1	1.1	1.1	0.58	5.6	490	NA	UG/KG		
Heptachlor	5	11	2.5	120	60.1	0.58	2.3	140	NA	UG/KG		
Heptachlor epoxide	4	11	2.15	22	7.5	0.58	5.6	70	NA	UG/KG		
Alpha-chlordane	4	6	4.7	160	51.2	1.9	2.3	1800	NA	UG/KG		
Gamma-chlordane	5	6	8.8	400	109	2.3	2.3	1800	NA	UG/KG		
Herbicides												
2,4,5-TP (Silvex)	1	1	0.11	0.11	0.11	NA	NA	63000	NA	UG/KG		
Semivolatile Organics												
1-Methyl naphthalene	1	5	44	44	44	1100	1300	310000	NA	UG/KG		
Anthracene	1	11	640	640	640	370	900	2300000	NA	UG/KG		
Benzo(g,h,i)perylene	1	11	850	850	850	370	760	310000	NA	UG/KG		
bis(2-Ethylhexyl)phthalate (BEHP)	6	11	22	750	229	370	870	46000	NA	UG/KG		
Butylbenzylphthalate	1	11	180	180	180	370	830	1600000	NA	UG/KG		
Di-n-butylphthalate	2	11	46	100	73	370	940	780000	NA	UG/KG		
Fluoranthene	5	11	25	7500	1566	370	1100	310000	NA	UG/KG		
Fluorene	1	11	180	180	180	370	840	310000	NA	UG/KG		
Phenanthrene	4	11	18	3300	869	370	760	230000	NA	UG/KG		
Pyrene	6	11	19	5600	985	370	850	230000	NA	UG/KG		
Volatile Organics												
Toluene	3	11	2	2	2	3	490	1600000	NA	UG/KG		

Table 10.6.13
Chemicals Present in Site Samples
AOC 681 - Surface Soil
Charleston Naval Complex
Charleston, South Carolina

Parameter	Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration Residential RBC	Background	Units	Number Exceeding RBC	Background
TPH - DRO												
TPH - Diesel Range Organics	1	2	150	150	150	12	12	NA	NA	UG/KG		
TCDD Equivalents												
Dioxin (TCDD Equivalents)	1	1	0.325	0.325	0.325	NA	NA	4.3	NA	NG/KG		
1234678-HpCDD	1	1	14.1	14.1	14.1	NA	NA	NA	NA	NG/KG		
1234678-HpCDF	1	1	4.89	4.89	4.89	NA	NA	NA	NA	NG/KG		
OCDD	1	1	124	124	124	NA	NA	NA	NA	NG/KG		
OCDF	1	1	10.1	10.1	10.1	NA	NA	NA	NA	NG/KG		

Notes:
* - Indicates chemical was identified as a COPC
N - Indicates chemical is an essential nutrient
SQL - Sample quantitation limit
RBC - Risk-based concentration
UG/KG - micrograms per kilogram
MG/KG - milligrams per kilogram
NG/KG - nanograms per kilogram
NA - Not applicable or not available
ND - Not determined due to lack of information

Building Surfaces

Lead was detected in six of seven wipe samples at concentrations ranging from 52 to 1,310 μg/wipe. Aluminum oxides were also detected in six of seven wipe samples at concentrations ranging from 671 to 19,200 μg/ wipe. All wipe samples were collected from surfaces in and immediately adjacent to the Building 681 blast booth and associated equipment. The maximum concentrations of both analytes were reported in a wipe sample collected from the surface of the blast booth vacuum. The affected floor area represents less than one-quarter of the total building space.

Shallow Groundwater

As shown in Table 10.6.14, Bis(2-ethylhexyl)phthalate was identified as the only COPC in shallow groundwater at AOC 681. Arsenic, manganese, and thallium were detected at maximum concentrations exceeding their RBCs, but not exceeding their respective background concentrations. Therefore, these inorganics were eliminated from further consideration in the HHRA. Wilcoxon rank sum test analyses did not result in the inclusion of any inorganic parameters that had been screened out on the basis of background concentration.

10.6.6.3 Exposure Assessment

Exposure Setting

AOC 681 is a blast booth located in Building 681. It is used to strip miscellaneous components. Average particulate air emissions from the booth are 0.0004 pounds per hour or 0.00175 tons per year. The future use of this AOC is unknown, although AOC 681 is located within an area slated for redevelopment as a marine cargo terminal according to current base reuse plans.

Table 10.6.14
Chemicals Present in Site Samples
AOC 681 — Shallow Groundwater
Charleston Naval Complex
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Conc.	Range of SQL		Screening Concentration RBC	Screening Concentration Background	Units	Number Exceeding RBC	Number Exceeding Bkgd.
Inorganics													
Aluminum (Al)		3	9	53.2	131	85.5	17	68	3700	1440	UG/L		
Arsenic (As)		6	9	3.3	8.1	5.28	3.3	7.7	0.045	23	UG/L	6	
Barium (Ba)		8	9	10.6	53.6	31.4	16.7	16.7	260	110	UG/L		
Calcium (Ca)	N	9	9	36900	203000	104756	NA	NA	NA	NA	UG/L		
Cobalt (Co)		1	9	1.7	1.7	1.70	1	4.5	220	2.2	UG/L		
Copper (Cu)		2	9	2.05	10.1	6.08	1.3	5.7	150	4.4	UG/L		1
Iron (Fe)	N	6	9	67	2500	1128	33	134	NA	NA	UG/L		
Lead (Pb)		1	9	3.3	3.3	3.30	1.2	2.1	15	4.4	UG/L		
Magnesium (Mg)	N	9	9	8750	54200	25078	NA	NA	NA	NA	UG/L		
Manganese (Mn)		9	9	4.3	89.15	43	NA	NA	73	5430	UG/L	2	
Mercury (Hg)		2	9	0.13	0.19	0.16	0.1	0.2	1.1	NA	UG/L		
Nickel (Ni)		2	9	2.1	2.3	2.2	1.5	5.7	73	13.3	UG/L		
Potassium (K)	N	9	9	6180	42800	21402	NA	NA	NA	NA	UG/L		
Selenium (Se)		1	6	2.9	2.9	3	2.9	3.1	18	NA	UG/L		
Sillver (Ag)		2	9	2.3	6.1	4	1.4	4.5	18	NA	UG/L		
Sodium (Na)	N	9	9	27300	479000	169250	NA	NA	NA	NA	UG/L		
Thallium (Tl)		1	9	2.4	2.4	2.40	1.6	3.1	0.26	6.6	UG/L	1	
Vanadium (V)		3	9	1.1	9.6	4.00	0.8	4.1	26	14	UG/L		
Zinc (Zn)		1	9	13.65	13.65	13.65	2.7	24.8	1100	24.4	UG/L		
Semivolatile Organics													
bis(2-Ethylhexyl)phthalate (BEHP)	*	3	9	1	22	8.7	5	13	4.8	NA	UG/L	1	
4-Nitrophenol		1	9	4	4	4.00	10	50	29.2	NA	UG/L		
Volatile Organics													
Carbon Disulfide		1	9	2	2	2.00	5	5	100	NA	UG/L		

Notes:
* — Identified as a COPC
N — Essential nutrient
SQL — Sample quantitation limit
UG/L — microgram per liter
NA — Not applicable

Since municipal water is readily available basewide, it is highly unlikely that the aquifer will be used as a source of potable or process water. Groundwater exposure pathways would not be completed if the municipal water supply is kept in place. As a highly conservative estimate of potential risk/hazard due to groundwater pathways, a residential scenario and an industrial scenario were considered for AOC 681.

Potentially Exposed Populations

Potentially exposed populations are current and future site workers. Additional potentially exposed populations are hypothetical future site residents and adolescent trespassers. Future site resident and worker exposure scenarios were addressed in this risk assessment. Current exposure to workers is discussed quantitatively in relation to the future workers and future residents. The hypothetical future site worker scenario assumed continuous exposure to surface soil conditions. Current site workers' exposure would be less than that assumed for the hypothetical future site worker scenario because of their limited soil contact. Therefore, future worker assessment is considered to be conservatively representative of current site workers. The resident child scenario was considered to be conservatively representative of the adolescent trespasser. The future site resident scenario was built on the premise that existing features would be removed and replaced with dwellings.

Exposure Pathways

Exposure pathways for the site workers are dermal contact and incidental ingestion of surface soils. The exposure pathways for future residential land use are the same as those for the future site worker. The hypothetical future site worker scenario assumed continuous exposure to surface soil conditions. The groundwater pathway for the hypothetical future site residents and site workers is incidental ingestion of groundwater. Uniform exposure was assumed for all sample locations. No VOCs were reported in AOC 681 groundwater samples at concentrations exceeding

residential RBCs; therefore the inhalation of volatiles pathway was not addressed for this site. 1
Table 10.6.15 presents the justification for exposure pathways assessed in this HHRA. 2

Table 10.6.15
Exposure Pathways Summary — AOC 681
Charleston Naval Complex — Zone I
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Current Land Uses			
Current Site Users/Maintenance	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	Little surface soil is exposed at AOC 681, inhibiting fugitive dust generation. Therefore, this exposure pathway was considered insignificant compared to the other pathways.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Shallow groundwater is not currently used as a source of potable or nonresidential water at AOC 681.
	Shallow groundwater, Inhalation of volatilized shallow groundwater contaminants	No	Shallow groundwater is not currently used as a source of potable or nonresidential water at AOC 681.
	Soil, Incidental ingestion	No (Qualified)	Future site use is considered to be conservatively representative of current use.
	Soil, Dermal contact	No (Qualified)	Future site use is considered to be conservatively representative of current use.
Future Land Uses			
Future Site Residents (Child and Adult) and Future Site Worker	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.

Table 10.6.15
Exposure Pathways Summary — AOC 681
Charleston Naval Complex — Zone I
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Future Site Residents (Child and Adult) and Future Site Worker (Continued)	Air, Inhalation of chemicals entrained in fugitive dust	No	Little surface soil is exposed at AOC 681, inhibiting fugitive dust generation. Therefore, this exposure pathway was considered insignificant compared to the other pathways.
	Shallow groundwater, Ingestion of contaminants during potable or general use	Yes	Shallow groundwater is not likely to be used as a source of potable water at AOC 681; however, this pathway was included as a conservative measure.
	Shallow groundwater, Inhalation of volatilized contaminants during domestic use	No	Shallow groundwater is not likely to be used as a source of domestic or process water at AOC 681. Volatile COPCs were not identified subsequent to risk-based screening comparisons.
	Soil, Incidental ingestion	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.
	Soil, Dermal contact	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.
	Wild game or domestic animals, Ingestion of tissue impacted by media contamination	No	Hunting/taking of game and/or raising livestock is prohibited within the Charleston, South Carolina city limits.
	Fruits and vegetables, Ingestion of plant tissues grown in media	No	The potential for significant exposure via this pathway is low relative to that of other exposure pathways assessed.

Exposure Point Concentrations

As discussed in Section 7 of this RFI, 95% UCLs were calculated for datasets consisting of at least 10 samples. The statistical analysis of surface soil pathway COPCs is presented in Table 10.6.16. The 95% UCLs were applied as the EPC. BEQs were detected in only four of eleven samples. All impacted soil samples were collected from an area of less than 1000 square feet immediately adjacent to a blast booth exhaust collection hopper. Samples collected outside this area had no

Table 10.6.16
Statistical Analysis of COPCs in Surface Soil
AOC 681 - Zone I
Charleston Naval Complex
Charleston, South Carolina

COPC	n	Natural Log Transformed mean	SD	H-stat	UCL (mg/kg)	MAX (mg/kg)	EPC (mg/kg)	
Benzo(a)pyrene Equivalents	11	-0.541	0.664	2.417	1.21	3.45	1.21	UCL
Chromium	10	3.312	0.676	2.492	60.5	79.2	60.5	UCL

NOTES:

mean arithmetic mean of the logtransformed data
n number of samples analyzed
SD standard deviation for a sample of data
H-stat "H" statistic from Gilbert 1987; cuboidal interpolation was used to determine the value in accordance with USEPA Supplemental Guidance to RAGS, Calculating the
EPC exposure point concentration
UCL 95 percentile upper confidence level mean
MAX maximum reported concentration

detectable cPAHs. Based on the limited extent of identified impacts, an FI/FC factor of 0.1 was conservatively estimated. This factor takes into consideration the size of the impacted area relative to a standard 0.5 acre exposure area. Because only 9 shallow groundwater samples were collected, no 95% UCLs were computed. The maximum bis(2-ethylhexyl)phthalate concentration (0.022 mg/L) was applied as the groundwater pathway EPC using the 'hot spot' approach.

Quantification of Exposure

Soil

CDIs for ingestion and dermal contact with soils are presented Tables 10.6.17 and 10.6.18, respectively.

Shallow Groundwater

CDIs for the groundwater pathway calculated as described in Section 7 are presented in Table 10.6.19.

10.6.6.4 Toxicity Assessment

Toxicity assessment terms and methods are discussed in Section 7 of this report. Table 10.6.20 presents toxicological information specific to the COPC identified at AOC 681. This information was used in the quantification of risk/hazard associated with soil and groundwater contaminants. A brief toxicological profile for each COPC is provided in the following paragraphs.

BEQs include the following list of polynuclear aromatic hydrocarbons (PAHs):

Benzo(a)anthracene	TEF	0.1
Benzo(b)fluoranthene	TEF	0.1
Dibenz(a,h)anthracene	TEF	1.0
Benzo(k)fluoranthene	TEF	0.01
Benzo(a)pyrene	TEF	1.0
Indeno(1,2,3-cd)pyrene	TEF	0.1
Chrysene	TEF	0.001

Table 10.6.17
Chronic Daily Intakes (CDI)
Incidental Ingestion of Surface Soil
AOC 681 Zone I
Charleston Naval Complex
Charleston, SC

Chemical	Fraction Ingested from Contaminated Source*	Exposure Point Concentration (mg/kg)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident LW C-CDI (mg/kg-day)	Future Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Benzo(a)pyrene Equivalent	0.1	1.21	1.65E-07	1.54E-06	1.89E-07	5.90E-08	2.11E-08
Chromium (Cr)	1	60.45	8.28E-05	7.73E-04	9.46E-05	2.96E-05	1.06E-05

NOTES:

LWA lifetime weighted average; used to calculate carcinogenic CDI, RAGS Parts A and B
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
* Reflects the estimated fraction of the site impacted by the corresponding COPC

Table 10.6.18
Chronic Daily Intakes (CDI)
Dermal Contact with Surface Soil
AOC 681 Zone I
Charleston Naval Complex
Charleston, SC

Chemical	Exposure Point Concentration (mg/kg)	Fraction Contacted from Contaminated Source *	Dermal Absorption Factor+ (unitless)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident LW C-CDI (mg/kg-day)	Future Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Benzo(a)pyrene Equivalent	1.21	0.1	0.01	6.77E-08	2.24E-07	4.24E-08	4.84E-08	1.73E-08
Chromium (Cr)	60.45	1	0.001	3.40E-06	1.12E-05	2.12E-06	2.43E-06	8.66E-07

NOTES:

LWA Lifetime Weighted Average
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
\+ The dermal absorption factor was applied to the exposure point concentration to reflect the different trans-dermal migration of inorganic versus organic chemicals
* Reflects the estimated fraction of the site impacted by the corresponding COPC.

Table 10.6.19
Chronic Daily Intakes (CDI)
Ingestion of COPCs in Shallow Groundwater
AOC 681 - Zone I
Charleston Naval Complex
Charleston, South Carolina

Chemical	Exposure Point Concentration (mg/liter)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident lwa C-CDI (mg/kg-day)	Future Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
bis(2-Ethylhexyl)phthalate	0.022	6.03E-04	1.41E-03	3.32E-04	2.15E-04	7.69E-05

NOTES:

lwa lifetime weighted average
CDI Chronic Daily Intake
H-CDI Non-carcinogenic hazard based Chronic Daily Intake
C-CDI Carcinogenic risk based Chronic Daily Intake

Table 10.6.20

Toxicological Reference Information

for Chemicals of Potential Concern

AOC 681 - Zone I

Charleston Naval Complex

Charleston, South Carolina

	Non-Carcinogenic Toxicity Data								*Carcinogenic Toxicity Data*			
Chemical	**Oral Reference Dose (mg/kg-day)**	**Confidence Level**	**Critical Effect**	**Uncertainty Factor Oral**	**Inhalation Reference Dose (mg/kg-day)**	**Confidence Level**	**Critical Effect**	**Uncertainty Factor Inhalation**	**Oral Slope Factor (kg-day/mg)**	**Inhalation Slope Factor (kg-day/mg)**	**Weight of Evidence**	**Tumor Type**
Aluminum	1 d	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
BEQ	NA	NA	NA	NA	NA	NA	NA	NA	7.3 a	3.1 d	B2	mutagen
bis(2-Ethylhexyl)phthalate	0.02 a	M	increased liver weight	1,000	NA	NA	NA	NA	0.014 a	0.034 d	B2	hepatoma
Chromium III	1.5 a	L	NA	100/10	NA	NA	NA	NA	NA	NA a	D	NA
Chromium VI	0.003 a	L	NA	900	3E-05 a	M	lower respiratory effects	300	NA	41 b	A	lung
Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	B2	various

Notes

a = Integrated Risk Information System (IRIS)

b = Health Effects Assessment Summary Tables (HEAST)

d = EPA NCEA - Cincinnati (provisional)

NA = Not applicable or not available

H = High confidence

L = Low confidence

M = Medium confidence

Some PAHs are toxic to the liver, kidney, and blood. However, the toxic effects of the PAHs above have not been well established. There are no RfDs for the PAHs above due to a lack of data. All PAHs listed above are classified by USEPA as B2 carcinogens, and their carcinogenicity is addressed relative to that of benzo(a)pyrene, having an oral SF 7.3 $(mg/kg/day)^{-1}$. Toxicity Equivalency Factors (TEFs), also set by USEPA, are multipliers that are applied to the detected concentrations, which are subsequently used to calculate excess cancer risk. Most carcinogenic PAHs have been classified as such due to animal studies using large doses of purified PAHs. There is some doubt as to the validity of these listings, and the SFs listed in USEPA's RBC table are provisional. However, these PAHs are carcinogens when the exposure involves a mixture of other carcinogenic substances (e.g., coal tar, soot, cigarette smoke, etc.). As listed in IRIS, the basis for the benzo(a)pyrene B2 classification is animal studies. Human data specifically linking benzo(a)pyrene to a carcinogenic effect are lacking. There are, however, multiple animal studies in many species demonstrating benzo(a)pyrene to be carcinogenic by numerous routes.

Lead has been classified as a group B2 carcinogen by USEPA based on animal data. No RfD or SF has been set by USEPA. However, an action level for soil protective of child residents has been proposed by USEPA Region IV: 400 mg/kg. USEPA's OSWER has recommended a 1,000 mg/kg cleanup standard for industrial properties. USEPA's Office of Water has established a treatment technique action level of 15 μg/L. As listed in IRIS, the classification is based on sufficient animal evidence. Ten rat bioassays and one mouse assay have shown statistically significant increases in renal tumors with dietary and subcutaneous exposure to several soluble lead salts. Animal assays provide reproducible results in several laboratories, in multiple rat strains with some evidence of multiple tumor sites. Short-term studies show that lead affects gene expression. Human evidence is inadequate. An RfD and SF have not been set because of the confounding nature of lead toxicity. Lead can accumulate in bone marrow, and effects have been observed in the CNS, blood, and mental development of children. RfDs are based on the assumption that a threshold must be exceeded to result in toxic effects (other than carcinogenicity).

Once lead accumulates in the body, other influences cause the actual levels in the blood to fluctuate — sometimes the lead is attached to binding sites; sometimes lead is free flowing. If an exposed individual has previously been exposed to lead, this individual could lose weight and set fat-bound lead free. This fluctuation and lack of previous lead exposure data are two of the reasons lead effects are difficult to predict (Klaassen et al., 1986).

Aluminum is one of the most abundant metals in the earth's crust (7% aluminum), and it is ubiquitous in air and water, as well as soil. This metal is water-soluble, silvery, and ductile, which suggests its usefulness in many processes. Ingesting aluminum can affect the absorption of other elements within the gastrointestinal tract and can alter intestinal function. Aluminum can potentially interfere with the absorption of essential nutrients and cholesterol. Another effect on the gastrointestinal system is the inhibition of acetylcholine-induced contractions, which are part of the neuro-muscular system controlling bowel muscles. The effect could explain why aluminum-containing antacids often produce constipation and indicates aluminum could affect the uptake of other chemicals. Aluminum dust is moderately flammable and explosive in heat. Inhaling this dust can cause fibrosis (aluminosis) (Klaassen, et al., 1986; Dreisbach et al., 1987). No data are available on an applicable SF or the USEPA cancer group. The USEPA Region IV Office of Health Assessment suggested using the provisional oral RfD of 1.0 mg/kg/day. The aesthetic-based secondary MCL (SMCL) for drinking water is 50 to 200 μg/L.

Chromium exists in two stable, natural forms: trivalent (CrIII) and hexavalent (CrVI). Acute exposure to chromium can result in kidney damage following oral exposure or damage to the nasal mucosa and septum following inhalation exposure. Chronic inhalation exposure to hexavalent chromium has resulted in kidney and respiratory tract damage, as well as excess lung cancer in both animals and humans following occupational exposure. Only hexavalent chromium is believed to be carcinogenic by inhalation (IRIS, 1999). Oral RfD values for both forms of chromium are

1.5 and 3E-3 (mg/kg/day). For trivalent chromium, the RfD is based on liver toxicity in the rat. For the hexavalent form, the RfD is based on unspecified pathological changes observed in rat studies. In addition, hexavalent chromium is considered a group A carcinogen for inhalation exposures, and an SF of 41 $(mg/kg/day)^{-1}$ has been established for the hexavalent form. Vitamin supplements contain approximately 0.025 mg of chromium. As listed in IRIS, no critical effects were observed for chromium (III). The uncertainty factor was 100 and the modifying factor was 10. As listed in IRIS, no critical effects were observed for chromium (VI). The uncertainty factor for chromium (VI) was 900 and the modifying factor was 1.

bis(2-Ethylhexyl)phthalate, otherwise known as BEHP, is a plasticizer used in virtually every major product category. Phthalate esters are ubiquitously distributed in the environment. Although the toxicity of this compound is relatively low, it is a carcinogen. Reproductive effects are also possible (indicated in animal studies) due to chronic exposure to BEHP. This compound is classified as a B2 carcinogen, and USEPA set the oral RfD and oral SF to 0.02 mg/kg-day and 0.014 $(mg/kg\text{-}day)^{-1}$, respectively (Klaassen et al., 1986).

10.6.6.5 Risk Characterization

Surface Soil Pathways

Exposure to surface soil onsite was evaluated under both residential and future industrial (site worker) scenarios. For these scenarios, the incidental ingestion and dermal contact exposure pathways were evaluated. For noncarcinogenic contaminants evaluated for future site residents, hazard was computed separately to address child and adult exposure. Tables 10.6.21 and 10.6.22 present the computed carcinogenic risks and/or HQs associated with the incidental ingestion of and dermal contact with site surface soils, respectively.

Table 10.6.21
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
AOC 681 Zone I
Charleston Naval Complex
Charleston, SC

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used $(mg/kg\text{-}day)^{-1}$	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident LW ILCR	Future Worker adult Hazard Quotient	Future Worker adult ILCR
Benzo(a)pyrene Equivalent	NA	7.3	ND	ND	1.4E-06	ND	1.5E-07
Chromium (Cr)	0.003	NA	0.028	0.0005	ND	0.00002	ND
SUM Hazard Index/ILCR			0.028	0.0005	1E-06	0.00002	2E-07

NOTES:

NA Not available
ND Not Determined due to lack of available information
LWA lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

Table 10.6.22
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
AOC 681 Zone I
Charleston Naval Complex
Charleston, SC

Chemical	Dermal Adjustment +	Oral RfD Used (mg/kg-day)	Oral SF Used $(mg/kg\text{-}day)^{-1}$	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident LWA ILCR	Future Worker adult Hazard Quotient	Future Worker adult ILCR
Benzo(a)pyrene Equivalents	0.5	NA	14.6	ND	ND	6.2E-07	ND	2.5E-07
Chromium (Cr)	0.2	0.0006	NA	0.0057	0.019	ND	0.0040	ND
SUM Hazard Index/ILCR				0.0057	0.019	6E-07	0.004	3E-07

NOTES:

NA Not available
ND Not Determined due to lack of available information
LWA lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk
\+ Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)

Hypothetical Site Residents

The ingestion ILCR (based on the adult and child lifetime weighted average) for AOC 681 surface soils is 1E-06, and the dermal pathway ILCR is 6E-07. Benzo(a)pyrene equivalents were the sole contributor. The ingestion hazard indicies for the adult and child resident are 0.03 and 0.0005, respectively. The dermal contact pathway hazard indicies for the adult and child resident are 0.006 and 0.02, respectively. Chromium was the sole contributor to HI.

Hypothetical Future Site Workers

Future site worker ILCRs are 2E-07 and 3E-07 for the ingestion and dermal contact pathways, respectively. Benzo(a)pyrene equivalents were the sole contributor. Site worker HQs are 0.00002 and 0.004 for the ingestion and dermal contact pathways respectively. Chromium was the sole contributor to HI.

The area in which soil samples were collected at AOC 681 is covered by an asphalt surface. Current site users have little chance of exposure to affected surface soil. As a result, the risk/hazard projections discussed above are considered gross overestimates should existing site features be maintained under future use scenarios.

Groundwater Pathways

Exposure to shallow groundwater onsite was evaluated under both residential and site worker scenarios. The ingestion exposure pathway was evaluated assuming the site groundwater will be used for potable and/or domestic purposes and that an unfiltered well, drawing from the corresponding water bearing zone, will be installed. For noncarcinogenic contaminants evaluated relative to future site residents, hazard was computed separately for child and adult receptors. Table 10.6.23 presents the risk and hazard for the ingestion pathway. Since no VOCs were identified as COPCs in groundwater at AOC 681, the inhalation pathway was not addressed at this site.

Table 10.6.23
Hazard Quotients and Incremental Lifetime Cancer Risks
Shallow Groundwater Ingestion
AOC 681
Charleston Naval Complex
Charleston, South Carolina

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used $(mg/kg\text{-}day)^{-1}$	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident LWA ILCR	Future Worker adult Hazard Quotient	Future Worker adult ILCR
bis(2-Ethylhexyl)phthalate	0.02	0.014	0.030	0.070	4.6E-06	0.011	1.1E-06
SUM Hazard Index/ILCR			0.03	0.07	5E-06	0.01	1E-06

Notes:
NA Not Available
ND Not Determined due to lack of
LWA lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

Hypothetical Site Residents

Bis(2-ethylhexyl)phthalate was the only COPC identified in shallow groundwater and is the sole contributor to ILCR and HI projections for the groundwater ingestion pathway. The ILCR for the future residential scenario is 5E-06. The hazard indices for the adult and child resident are 0.03 and 0.07, respectively.

Hypothetical Future Site Workers

The groundwater pathway risk for the future site worker scenario is 1E-06 and the hazard index is 0.01. Bis(2-ethylhexyl)phthalate was the sole contributor to ILCR and HI projections associated with the groundwater ingestion pathway.

Current Site Workers

Shallow groundwater is not currently used as a potable water source for AOC 681 or other areas of Zone I. In the absence of a completed exposure pathway, no threat to human health is posed by reported shallow groundwater quality.

COCs Identified

Chemicals of concern were identified based on cumulative (all pathway) risk and hazard projected for this site. USEPA has established a generally acceptable risk range of 1E-04 to 1E-06, and a HI threshold of 1 (unity). As recommended by SCDHEC, a COC was considered to be any chemical contributing to a cumulative risk level of 1E-06 or greater and/or a cumulative HI above 1, and whose individual ILCR exceeds 1E-06 or whose HQ exceeds 0.1. For carcinogens, this approach is relatively conservative, because a cumulative risk level of 1E-04 (and individual ILCR of 1E-06) is recommended by USEPA Region IV as the trigger for establishing COCs. The COC selection algorithm presented was used in order to provide a more comprehensive evaluation of chemicals contributing to carcinogenic risk or noncarcinogenic hazard during the remedial goal options development process. Table 10.6.24 presents the COCs identified for AOC 681 surface soil and groundwater.

Surface Soils

Future Site Residents

BEQs were identified as soil pathway COCs based on their contribution to cumulative ILCR projections.

Future Site Workers

No soil pathway COC was identified based on its contribution to cumulative ILCR or hazard projections.

The extent of the COCs identified in surface soil is briefly discussed below. Because the COC was reported at four of eleven locations, it was relatively apparent that the extend of surface soil impacts was limited. The FI/FC factor of 0.1 was conservatively estimated based on the distance between sampling points and the total potential exposure area. Asphaltic materials overlie most locations. Although sampling methods attempted to preclude or minimize asphaltic materials in the borehole, it is possible that these materials could have served as a source of cPAHs, if fragments were entrained in underlying soil during borehole advancement.

Groundwater

Future Site Residents

Bis(2-ethylhexyl)phthalate was identified as a groundwater pathway COC based on its contribution to cumulative residential ILCR projections.

Table 10.6.24
Summary of Risk and Hazard-based COCs for AOC 681
Charleston Naval Complex, Zone I
Charleston, South Carolina

Medium	Exposure Pathway		Future Resident Adult Hazard Quotient	Future Resident Child Hazard Quotient	Future Resident LWA ILCR	Site Worker Hazard Quotient	Site Worker ILCR	Identification of COCs	
Surface Soil	Incidental Ingestion	Benzo(a)pyrene Equivalent	ND	ND	1.4E-06	ND	1.5E-07	2	
		Chromium (Cr)	0.028	0.0005	ND	0.00002	ND		
	Dermal Contact	Benzo(a)pyrene Equivalent	ND	ND	6.2E-07	ND	2.5E-07		
		Chromium (Cr)	0.0057	0.019	ND	0.004	ND		
Surface Soil Pathway Sum			0.033	0.019	2E-06	0.0041	4E-07		
Groundwater	Ingestion	bis(2-Ethylhexyl)phthalate	0.03	0.07	4.6E-06	0.011	1.1E-06	2	4
Groundwater Pathway Sum			0.03	0.07	4.6E-06	0.011	1E-06		
Sum of all Pathways			0.06	0.09	7E-06	0.015	1E-06		

Notes:
ND - not determined due to the lack of available risk information.
ILCR - incremental excess lifetime cancer risk
HI - hazard index
LWA - Lifetime Weighted Average
1- Chemical is a COC by virtue of projected child residence non-carcinogenic hazard.
2- Chemical is a COC by virtue of projected future resident lifetime ILCR.
3- Chemical is a COC by virtue of projected site worker non-carcinogenic hazard.
4- Chemical is a COC by virtue of projected site worker ILCR.

Future Site Workers

Bis(2-ethylhexyl)phthalate was identified as a groundwater pathway COC based on its contribution to cumulative industrial ILCR projections.

Bis(2-ethylhexyl)phthalate was detected at a concentration exceeding its tap water RBC (4.8 mg/L) in one groundwater sample.

10.6.6.6 Risk Uncertainty

Characterization of Exposure Setting and Identification of Exposure Pathways

The potential for high bias is introduced through the exposure setting and pathway selection due to the highly conservative assumptions (i.e., future residential use) recommended by USEPA Region IV when assessing potential future and current exposure. The exposure assumptions made in the future site worker scenario are highly protective and would tend to overestimate exposure. The area sampled at AOC 681 is covered by an asphalt surface, thus precluding exposure to affected surface soil. Current site workers are not exposed to site groundwater.

Residential use of the site would not be expected, based on current site uses and the nature of surrounding buildings. Current reuse plans call for continued commercial/industrial use of this portion of Zone I, and the AOC 681 area is slated to become a marine cargo terminal. If this area were to be used as a residential site, the buildings would be demolished, asphalt surface removed, and the surface soil conditions would likely change — the soils could be covered with landscaping soil and/or a house. Consequently, exposure to current surface soil conditions would not be likely under a true future residential scenario. These factors indicate that exposure pathways assessed in this HHRA would generally overestimate the risk and hazard posed to current site workers and future site residents.

Shallow groundwater is not currently used at AOC 681 for potable or industrial purposes. A basewide system provides drinking and process water to buildings throughout Zone I. This system is slated to remain in operation under the current base reuse plan. As a result, shallow groundwater would not be expected to be used under future site use scenarios. Therefore, the screening scenario established for this site associated with shallow groundwater exposure is highly conservative and associated pathways are not expected to be completed in the future.

Determination of Exposure Point Concentrations

The 95 % UCL was applied as the EPC for chromium in surface soil. Because BEQs were detected in only a limited number of samples and in an extremely small area (less than 1000 square feet), use of the FI/FC factor to modify the 95% UCL applied as the EPC was deemed appropriate. No 95% UCLs were calculated for the COPC in shallow groundwater because less than ten samples were analyzed for the identified COPC. The maximum concentration of bis(2-ethylhexyl)phthalate was applied as the EPC.

Frequency of Detection and Spatial Distribution

Soil

The maximum concentration of chromium was reported in the surface sample at 681SB008. The maximum concentration of benzo(a)pyrene equivalents was reported in the surface sample at 681SB009. Each of the samples in which benzo(a)pyrene equivalents were detected was collected within approximately 20 feet of the outside paint chip hopper. A conservative FI/FC factor of 0.1 was assumed for BEQs considering the limited extent of impacts. Further sampling in the vicinity of the reportedly impacted surface soil locations would likely serve to further reduce the FI/FC factor, and thus exposure estimates.

Groundwater

Bis(2-ethylhexyl)phthalate exceeded its tap water RBC in one groundwater sample (681002) in the first sampling event and was detected below its tap water RBC in wells 681002 and 681003 during the second sampling event. Bis(2-ethylhexyl)phthalate was not detected in the third sampling event.

Quantification of Risk/Hazard

As indicated by the discussions above, the uncertainty inherent in the risk assessment process is great. In addition, many site-specific factors have affected the uncertainty of this assessment that would upwardly bias the risk and hazard estimates. Exposure pathway-specific sources of uncertainty are discussed below.

Soil

Of the CPSSs screened and eliminated from formal assessment, none was reported at a concentration close to its corresponding RBC (i.e., within approximately 10% of the RBC). This minimizes the likelihood of potentially significant cumulative risk/hazard based on the eliminated CPSSs. Concentrations of aluminum, arsenic, and manganese exceeded their corresponding RBCs, but did not exceed their corresponding reference concentrations. Therefore, they were eliminated from formal assessment based on comparisons to reference concentrations.

Although the future land use at this site is unknown, both the future worker and residential exposure scenarios were assessed in this HHRA. Current base reuse plans call for conversion of the area to be a marine cargo terminal. As previously discussed, these scenarios would likely lead to overestimates of risk and/or hazard.

Groundwater

The same conservative screening process used for soil is also used for groundwater. Of the CPSSs screened and eliminated from formal assessment, none were reported at a concentration close to its corresponding RBC (e.g. within 10% of their RBCs). Arsenic, manganese, and thallium were detected at concentrations exceeding their tap water RBCs, however, their maximum concentrations did not exceed their corresponding background concentrations. As a result, each chemical was eliminated from consideration in the risk assessment.

Groundwater is not currently used as a potable water source at AOC 681, nor is it used in the surrounding area. Municipal water is readily available. As previously mentioned, it is highly unlikely that the site will be developed as a residential area, and it is unlikely that a potable-use well would be installed onsite. It is probable that, if residences were constructed onsite and an unfiltered well were installed, the salinity and dissolved solids would preclude this aquifer from being an acceptable potable water source.

Background — Related Risk

Soil

Aluminum, arsenic, and manganese were detected in AOC 681 surface soil at concentrations above their respective RBCs. These elements were eliminated from consideration in the risk assessment based on comparison to corresponding background values. It is not unusual for naturally occurring or background concentrations of some elements to exceed risk-based concentrations. It is the risk assessments function to identify excess risk and/or hazard, or that which is above background levels. The following is a discussion of the residential scenario risk/hazard associated with background-concentrations of aluminum, arsenic, and manganese.

The maximum surface soil concentration of aluminum (11900 mg/kg) for AOC 681 equates with HQs of 0.16 and 0.008 for the residential child and site worker, respectively. The background value for aluminum (27,400 mg/kg) resulted in HQs of 0.38 and 0.02 for the residential child and site worker, respectively. The maximum surface soil concentration of arsenic (6.6 mg/kg) equates with ILCRs of 1.7E-05 and 2E-06 for the residential and site worker scenarios, respectively. The maximum reported concentration of arsenic equates with HQs of 0.3 and 0.015 for the residential child and site worker, respectively. The background value for arsenic (21.6 mg/kg) equates with ILCRs of 5.6E-05 and 8E-06, and HQs of 0.99 and 0.05 for the residential and site worker scenarios, respectively. The maximum surface soil concentration of manganese (250 mg/kg) equates with hazard quotients of 0.07 and 0.007 for the residential child and site workers, respectively. The background value for manganese (419 mg/kg) results in HQs of 0.12 and 0.013 for the residential child and site worker, respectively.

Groundwater

Arsenic, manganese, and thallium were detected in groundwater samples at concentrations exceeding their respective RBCs. These inorganics were eliminated from consideration in the risk assessment based on comparison to corresponding background values. The following is a discussion of the residential scenario risk/hazard associated with background concentrations of arsenic, manganese, and thallium.

The maximum reported concentration of arsenic (8.1 μg/L) yielded HQs of 1.7 and 0.5 for the residential and site worker scenarios, respectively. The maximum reported concentration of arsenic equates with ILCRs of 1.8E-04 and 8.5E-05 for the residential child and site worker scenarios, respectively. The background concentration for arsenic (23 μg/L) equates with ILCRs of 5.1E-04 and 2.4E-04, and HQs of 4.9 and 1.5 for the residential and site worker scenarios, respectively. The maximum reported concentration of manganese (89.15 μg/L) yielded HQs of 0.1 and 0.08 for the residential child and site worker secenarios, respectively. HQs resulting from the background concentration for manganese (5430 μg/L) were 6.5 and 4.6 for the residential child and site worker, respectively. The maximum groundwater concentration of thallium (2.4 μg/L) for AOC 681 equates with HQs of 1.9 and 0.6 for the residential child and site worker, respectively. The background value for thallium (6.6 μg/L) equates with HQs of 5.3 and 1.6 for the residential child and site worker, respectively.

10.6.6.7 Risk Summary

The risk and hazard posed by contaminants at AOC 681 were assessed for the hypothetical site worker and the hypothetical future site resident under reasonable maximum exposure assumptions. In surface soils, the incidental ingestion and dermal contact pathways were assessed in this HHRA. The ingestion pathway was assessed for groundwater. Table 10.6.25 presents the risk summary for each pathway/receptor group evaluated for AOC 681.

Soil — Residential Scenario

The residential soil pathway COCs identified for AOC 681 are BEQs. Figure 10.6.7 illustrates point risk estimates for AOC 681 based on surface soil exposure pathways under a future residential scenario. Table 10.6.26 summarizes the risk and hazard contribution of each COPC at each sample location. This point risk map is based on the unlikely assumption that a potential future site resident will be chronically exposed to specific points. Exposure to surface soil conditions is more likely the result of uniform exposure to the soil conditions of the entire site (or exposure unit area) rather than specific points. With this in mind, risk maps supplemented by the tables are useful in that they allow the reader to visualize how chemicals driving risk estimates are spatially distributed across the site.

Only four sample locations yielded ILCRs that were greater than 1E-06. Benzo(a)pyrene equivalents were the primary contributors to risk. Risk estimates at AOC 681 ranged from 1E-06 at 681SB002 to 6E-05 at 681SB009.

Chromium was a primary contributor to hazard estimates at AOC 681. None yielded a hazard index above unity. Hazard index estimates ranged from 0.03 at 681SB001 to 0.2 at 681SB008.

Table 10.6.25
Summary of Risk and Hazard
AOC 681 - Zone I
Charleston Naval Complex
Charleston, South Carolina

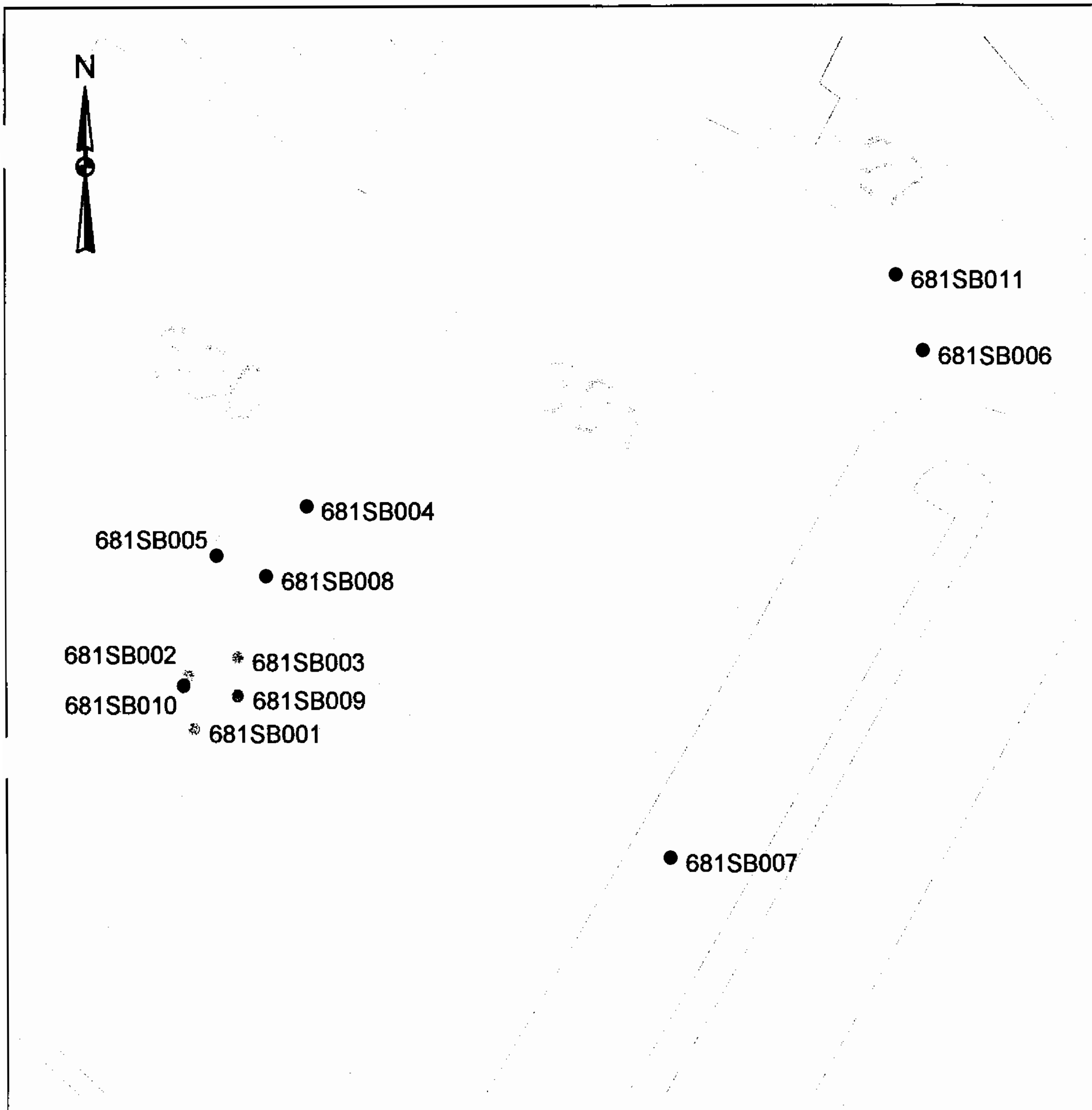
Medium	Exposure Pathway	HI (Adult)	HI (Child)	ILCR (LWA)	HI (Worker)	ILCR (Worker)
Surface Soil	Incidental Ingestion	0.028	0.0005	1E-06	0.00002	2E-07
	Dermal Contact	0.006	0.019	6E-07	0.004	3E-07
Sum of Surface Soil Pathways		0.03	0.02	2E-06	0.004	4E-07
Groundwater	Ingestion	0.03	0.07	5E-06	0.011	1E-06
Sum of Groundwater Pathways		0.03	0.07	5E-06	0.011	1E-06
Sum of All Pathways		0.06	0.09	7E-06	0.015	1E-06

Notes:
ND indicates not determined due to the lack of available risk information.
ILCR indicates incremental excess lifetime cancer risk
HI indicates hazard index

Table 10.6.26
Point Estimates of Risk and Hazard — Surface Soil Pathways
Residential Scenario
AOC 681
Charleston Naval Complex
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	Risk (E-06)
681	001	Benzo(a)pyrene Equivalents	102	UG/L	NA	1.69
		Chromium (Cr)	10.7	UG/L	0.029	NA
				Total	0.029	1.69
681	002	Benzo(a)pyrene Equivalents	69.2	UG/L	NA	1.15
		Chromium (Cr)	15.7	UG/L	0.043	NA
				Total	0.043	1.15
681	003	Benzo(a)pyrene Equivalents	165	UG/L	NA	2.73
		Chromium (Cr)	26.7	UG/L	0.073	NA
				Total	0.073	2.73
681	004	Benzo(a)pyrene Equivalents	ND	UG/L	NA	NA
		Chromium (Cr)	22.4	UG/L	0.061	NA
				Total	0.061	NA
681	005	Benzo(a)pyrene Equivalents	ND	UG/L	NA	NA
		Chromium (Cr)	NT	UG/L	NA	NA
				Total	NA	NA
681	006	Benzo(a)pyrene Equivalents	ND	UG/L	NA	NA
		Chromium (Cr)	14.3	UG/L	0.039	NA
				Total	0.039	NA
681	007	Benzo(a)pyrene Equivalents	ND	UG/L	NA	NA
		Chromium (Cr)	17.85	UG/L	0.049	NA
				Total	0.049	NA
681	008	Benzo(a)pyrene Equivalents	ND	UG/L	NA	NA
		Chromium (Cr)	79.2	UG/L	0.217	NA
				Total	0.217	NA
681	009	Benzo(a)pyrene Equivalents	3445.2	UG/L	NA	57.05
		Chromium (Cr)	44.1	UG/L	0.121	NA
				Total	0.121	57.05
681	010	Benzo(a)pyrene Equivalents	ND	UG/L	NA	NA
		Chromium (Cr)	32.6000	UG/L	0.089	NA
				Total	0.089	NA
681	011	Benzo(a)pyrene Equivalents	ND	UG/L	NA	NA
		Chromium (Cr)	73.5000	UG/L	0.202	NA
				Total	0.202	NA

param - soil - res	risk	haz
Benzo(a)pyrene Equivalents	0.0165603128	0
Chromium	0	0.0027424681



LEGEND

- NO COPCs
- < 1E-6
- 1E-6 to 5E-6
- 5E-6 to 1E-5
- 1E-5 to 1E-4
- > 1E-4

50 0 50 100 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.6.7
ZONE I
AOC 681

SURFACE SOIL POINT RISK
RESIDENTIAL SCENARIO

Soil — Site Worker Scenario

No industrial soil pathway COCs were identified for AOC 681.

Groundwater — Residential Scenario

Bis(2-ethylhexyl)phthalate was identified as a groundwater pathway COC. As shown in Table 10.6.27 bis(2-ethylhexyl)phthalate was the sole contributor to risk and hazard projections for AOC 681groundwater. Risk estimates ranged from 2E-07 at 68100202 to 5E-06 at 68100201. Bis(2-ethylhexyl)phthalate was the primary contributor to hazard estimates. Figures 10.6-8 and 10.6-9 illustrate point hazard and risk estimates for groundwater for the residential scenario. Hazard estimates ranged from 0.003 at 68100202 to 0.07 at 68100201.

Groundwater — Industrial Scenario

Bis(2-ethylhexyl)phthalate was identified as a groundwater pathway COC. As shown in Table 10.6.28 and Figure 10.6-10, bis(2-ethylhexyl)phthalate was the sole contributor to risk projections for AOC 681 groundwater. Risk estimates ranged from 1E-07 at 68100202 to 2E-06 at 68100201. Bis(2-ethylhexyl)phthalate was the primary contributor to hazard estimates. Figure 10.6-11 illustrates point hazard estimates for groundwater for the industrial scenario. Hazard estimates ranged from 0.001 at 68100202 to 0.02 at 68100201.

10.6.6.8 Remedial Goal Options

Soil

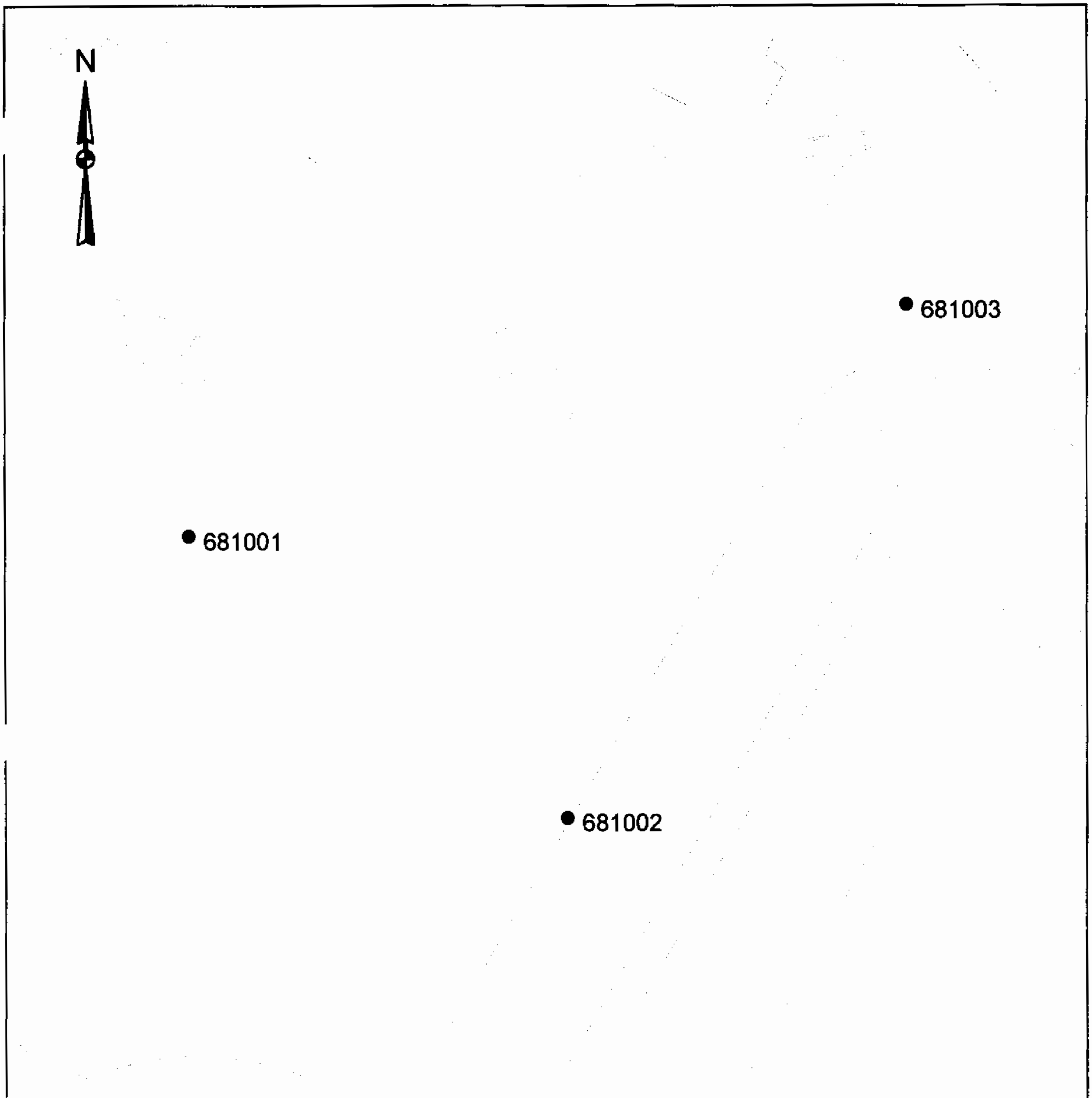
RGOs for carcinogens were based on the lifetime weighed average site resident as presented in Table 10.6.29 for surface soil. No hazard-based RGOs were necessary.

Groundwater

Groundwater RGOs based on the site resident scenarios and site worker are shown in Table 10.6.30 and 10.6.31, respectively.

Table 10.6.27
Point Estimates of Risk and Hazard — Groundwater Pathways
Residential Scenario
AOC 681
Charleston Naval Complex
Charleston, South Carolina

Site	Location	Round	Parameter	Concentration	Units	Hazard Index	Risk (E-06)
681	001	01	bis(2-ethylhexyl)phthalate	ND	UG/L	NA	NA
					Total	NA	NA
681	001	02	bis(2-ethylhexyl)phthalate	ND	UG/L	NA	NA
					Total	NA	NA
681	001	03	bis(2-ethylhexyl)phthalate	ND	UG/L	NA	NA
					Total	NA	NA
681	002	01	bis(2-ethylhexyl)phthalate	22	UG/L	0.070	4.58
					Total	0.070	4.58
681	002	02	bis(2-ethylhexyl)phthalate	1	UG/L	0.003	0.21
					Total	0.003	0.21
681	002	03	bis(2-ethylhexyl)phthalate	ND	UG/L	NA	NA
					Total	NA	NA
681	003	01	bis(2-ethylhexyl)phthalate	ND	UG/L	NA	NA
					Total	NA	NA
681	003	02	bis(2-ethylhexyl)phthalate	3	UG/L	0.010	0.62
					Total	0.010	0.62
681	003	03	bis(2-ethylhexyl)phthalate	ND	UG/L	NA	NA
					Total	NA	NA



LEGEND

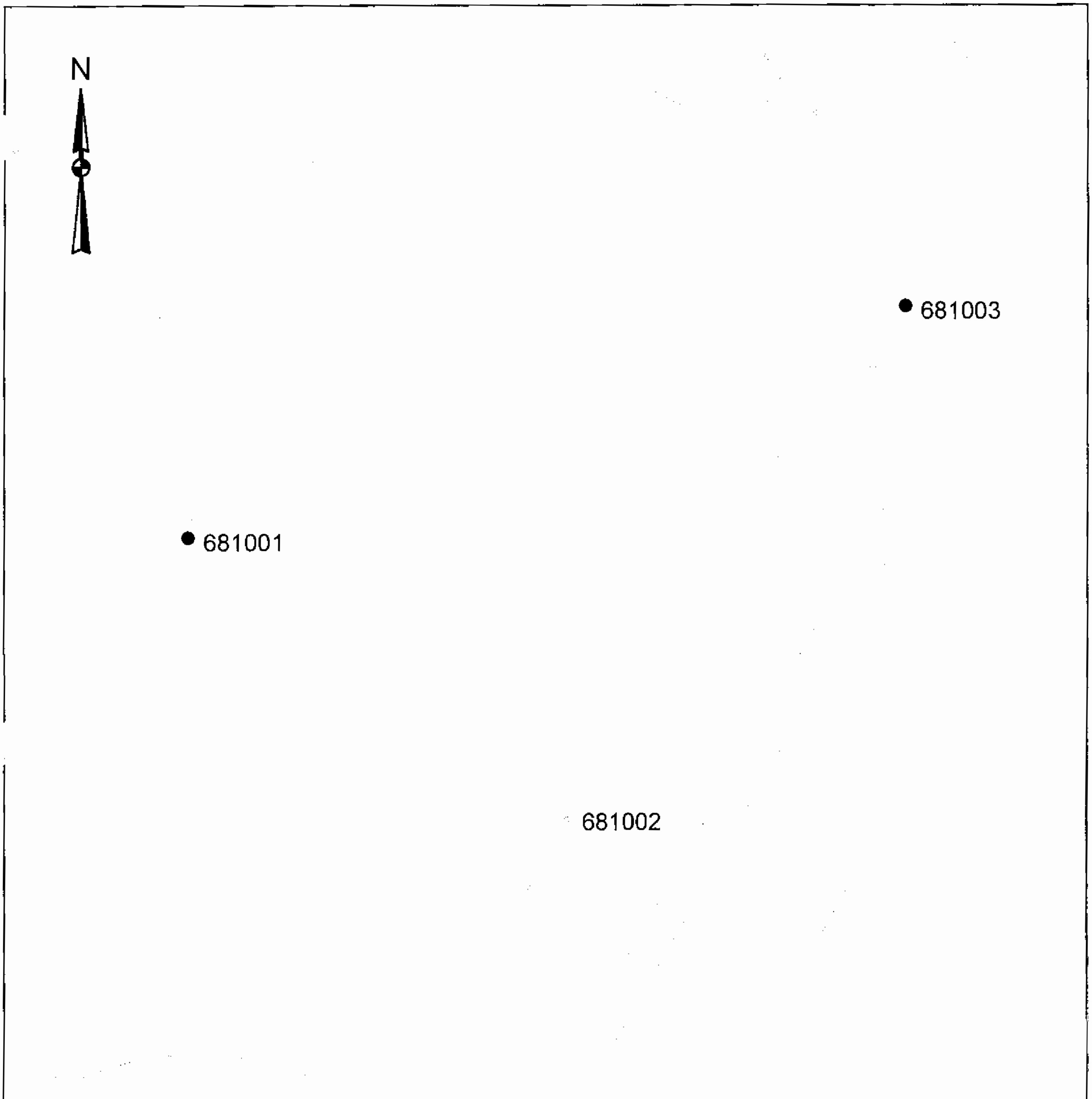
- NO COPCs
- 0 to 0.1
- 0.1 to 0.5
- 0.5 to 1.0
- 1.0 to 3.0
- > 3.0

50 0 50 100 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.6.8
ZONE I
AOC 681

GROUNDWATER POINT HAZARD
RESIDENTIAL SCENARIO



LEGEND

- NO COPCs
- < 1E-6
- 1E-6 to 5E-6
- 5E-6 to 1E-5
- 1E-5 to 1E-4
- > 1E-4

50 0 50 100 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.6.9
ZONE I
AOC 681

GROUNDWATER POINT RISK
RESIDENTIAL SCENARIO

Table 10.6.28
Point Estimates of Risk and Hazard — Groundwater Pathways
Industrial Scenario
AOC 681
Charleston Naval Complex
Charleston, South Carolina

Site	Location	Round	Parameter	Concentration	Units	Hazard Index	Risk (E-06)
681	001	01	bis(2-ethylhexyl)phthalate	ND	UG/L	NA	NA
					Total	NA	NA
681	001	02	bis(2-ethylhexyl)phthalate	ND	UG/L	NA	NA
					Total	NA	NA
681	001	03	bis(2-ethylhexyl)phthalate	ND	UG/L	NA	NA
					Total	NA	NA
681	002	01	bis(2-ethylhexyl)phthalate	22	UG/L	0.022	2.15
					Total	0.022	2.15
681	002	02	bis(2-ethylhexyl)phthalate	1	UG/L	0.001	0.10
					Total	0.001	0.10
681	002	03	bis(2-ethylhexyl)phthalate	ND	UG/L	NA	NA
					Total	NA	NA
681	003	01	bis(2-ethylhexyl)phthalate	ND	UG/L	NA	NA
					Total	NA	NA
681	003	02	bis(2-ethylhexyl)phthalate	3	UG/L	0.003	0.29
					Total	0.003	0.29
681	003	03	bis(2-ethylhexyl)phthalate	ND	UG/L	NA	NA
					Total	NA	NA

param - gw - res	risk	haz
bis(2-ethylhexyl)phthalate	0.097847358	0.0009784736

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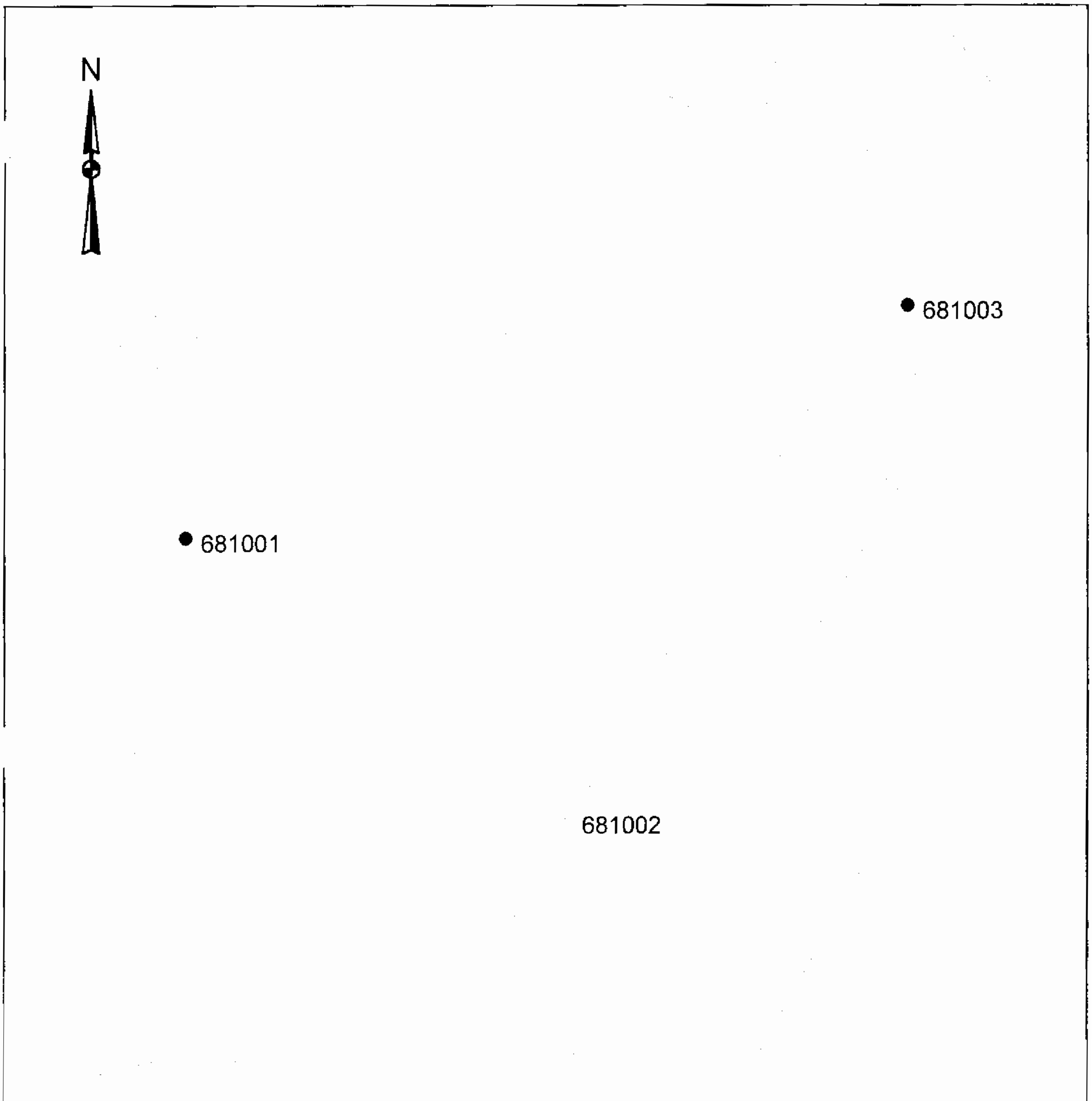


LEGEND

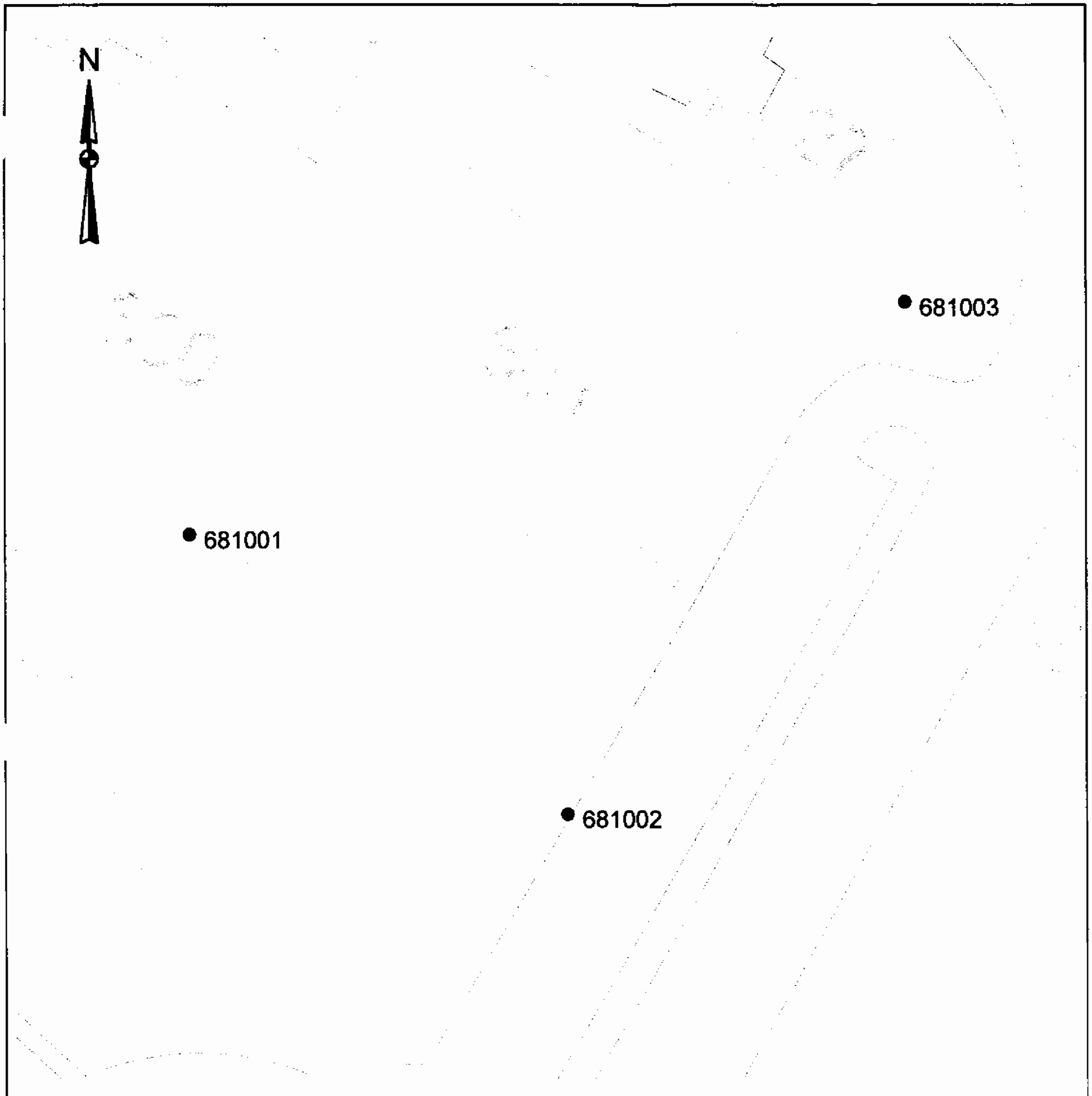
- NO COPCs
- < 1E-6
- 1E-6 to 5E-6
- 5E-6 to 1E-5
- 1E-5 to 1E-4
- > 1E-4

50 0 50 100 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.6.10
ZONE I
AOC 681

GROUNDWATER POINT RISK
INDUSTRIAL SCENARIO



LEGEND

- NO COPCs
- 0 to 0.1
- 0.1 to 0.5
- 0.5 to 1.0
- 1.0 to 3.0
- > 3.0

50 0 50 100 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.6.11
ZONE I
AOC 681

GROUNDWATER POINT HAZARD
INDUSTRIAL SCENARIO

Table 10.6.29
Residential-Based Remedial Goal Options Surface Soil
AOC 681 Zone I
Charleston Naval Complex
Charleston, South Carolina

Chemical	Slope Factor $(mg/kg\text{-}day)^{-1}$	Reference Dose (mg/kg-day)	EPC mg/kg	**Hazard-Based Remedial Goal Options** 3 mg/kg	1 mg/kg	0.1 mg/kg	**Risk-Based Remedial Goal Options** 1E-06 mg/kg	1E-05 mg/kg	1E-04 mg/kg	Background Concentration mg/kg
Benzo(a)pyrene Equivalents	7.3	NA	1.21	ND	ND	ND	0.60	6.0	60	NA

EPC exposure point concentration
NA not applicable
ND not determined
- remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident for noncarcinogens

Table 10.6.30
Residential-Based Remedial Goal Options Shallow Groundwater
AOC 681
Charleston Naval Complex
Charleston, South Carolina

Chemical	Oral SF (mg/kg-day)$^{-1}$	Oral RfD (mg/kg-day)	EPC mg/l	Hazard-Based Remedial Goal Options 0.1 mg/l	1.0 mg/l	3 mg/l	Risk-Based Remedial Goal Options 1E-06 mg/l	1E-05 mg/l	1E-04 mg/l	MCL mg/l	Background Concentration mg/l
bis(2-Ethylhexyl)phthalate	0.014	0.02	0.022	0.031	0.31	0.94	0.00474	0.0474	0.474	NA	NA

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined
- remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident for noncarcinogens

Table 10.6.31
Worker-Based Remedial Goal Options Shallow Groundwater
AOC 681
Charleston Naval Complex
Charleston, South Carolina

Chemical	Oral SF (mg/kg-day)$^{-1}$	Oral RfD (mg/kg-day	EPC mg/l	**Hazard-Based Remedial Goal Options** **0.1** mg/l	**1.0** mg/l	**3** mg/l	**Risk-Based Remedial Goal Options** **1E-06** mg/l	**1E-05** mg/l	**1E-04** mg/l	MCL mg/l	Background Concentration mg/l
bis(2-Ethylhexyl)phthalate	0.014	0.02	0.022	0.204	2.04	6.13	0.0204	0.204	2.04	NA	NA

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined

10.6.7 Corrective Measures Considerations

Based on the analytical results and the human health risk assessment for AOC 681, COCs requiring further evaluation through the CMS process have been identified for surface soil and groundwater. The site is currently in a moderately developed urban setting and risk to human health was evaluated under both the future residential and future industrial (site worker) scenarios. For these scenarios, the incidental ingestion and dermal contact exposure pathways were evaluated. Hazard was evaluated for noncarcinogenic contaminants through incidental ingestion and dermal contact scenarios as well.

As recommended by SCDHEC, a COC is considered to be any chemical contributing to a cumulative risk level of 1E-06 or greater and/or a cumulative hazard index above 1, and whose individual risk exceeds 1E-06 or whose hazard quotient exceeds 0.1.

BEQs were identified as soil pathway COCs for AOC 681. Bis(2-Ethylhexyl)phthalate (BEHP) was identified as a groundwater pathway COC for AOC 681. Table 10.6.32 presents cumulative and COC-specific exposure risks and hazard quotients.

Risk-based remedial goals for surface soil and groundwater are presented in Tables 10.6.29, 10.6.30, and 10.6.31. Potential corrective measures for soil are presented in Table 10.6.33.

Table 10.6.32
AOC 681
Cumulative and Chemical-Specific Exposure Risks and Hazard

Chemical	Risk: Industrial	Risk: Residential	Hazard: Industrial	Hazard: Residential
Soil				
BEQs	4E-7	2E-6	ND	ND
Cumulative	4E-7	2E-6	ND	ND
Groundwater				
BEHP	1.1E-6	4.6E-6	0.011	0.07
Cumulative	1.1E-6	4.6E-6	0.011	0.07

Note:
ND = Not detected

Table 10.6.33
AOC 681
Potential Corrective Measures

Medium	Compounds	Potential Corrective Measures
Soil	BEQs	a) No action b) Excavate, offsite disposal, and monitoring c) Containment/capping
Groundwater	BEHP	a) No action b) Monitoring c) Ex-situ physical/chemical treatment and discharge to POTW d) Ex-situ physical/chemical treatment and discharge through NPDES permitting

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10.7 AOC 685, Former Smoke Drum Site

AOC 685, is a former smoke drum site, located on the west side of Juneau Avenue. The facility was in operation from 1941 until 1953. The smoke drum area was reportedly used to burn classified documents and other materials, possibly paints, solvents, or waste oil. The area is now a grassy field with no visible evidence of the former site activities; no activities are currently associated with the site. Specific design features, dimensions, and operating practices of the smoke drum are unknown.

Products of incomplete combustion are the materials of concern at AOC 685. Potential receptors include workers who perform invasive activities which bring them in direct contact with contaminants.

To fulfill the CSI objectives and confirm the presence of contamination from onsite activities, soil and groundwater were sampled in accordance with the approved final RFI work plan and Section 3 of this report.

10.7.1 Soil Sampling and Analysis

Soil was sampled in three rounds at AOC 685 from the locations shown on Figure 10.7.1. The final RFI work plan proposed collecting nine soil samples from the upper-interval and nine from the lower-interval. All nine first-round upper-interval samples were collected. No lower-interval soil samples were collected because the water table was encountered at less than 5 ft bgs; saturated samples were not submitted for analysis. First-round samples were submitted for analysis of organotins and the standard suite of parameters, which includes VOCs, SVOCs, metals, cyanide, pesticides, and PCBs at DQO Level III. One first-round duplicate sample was submitted for Appendix IX parameters at DQO Level IV.

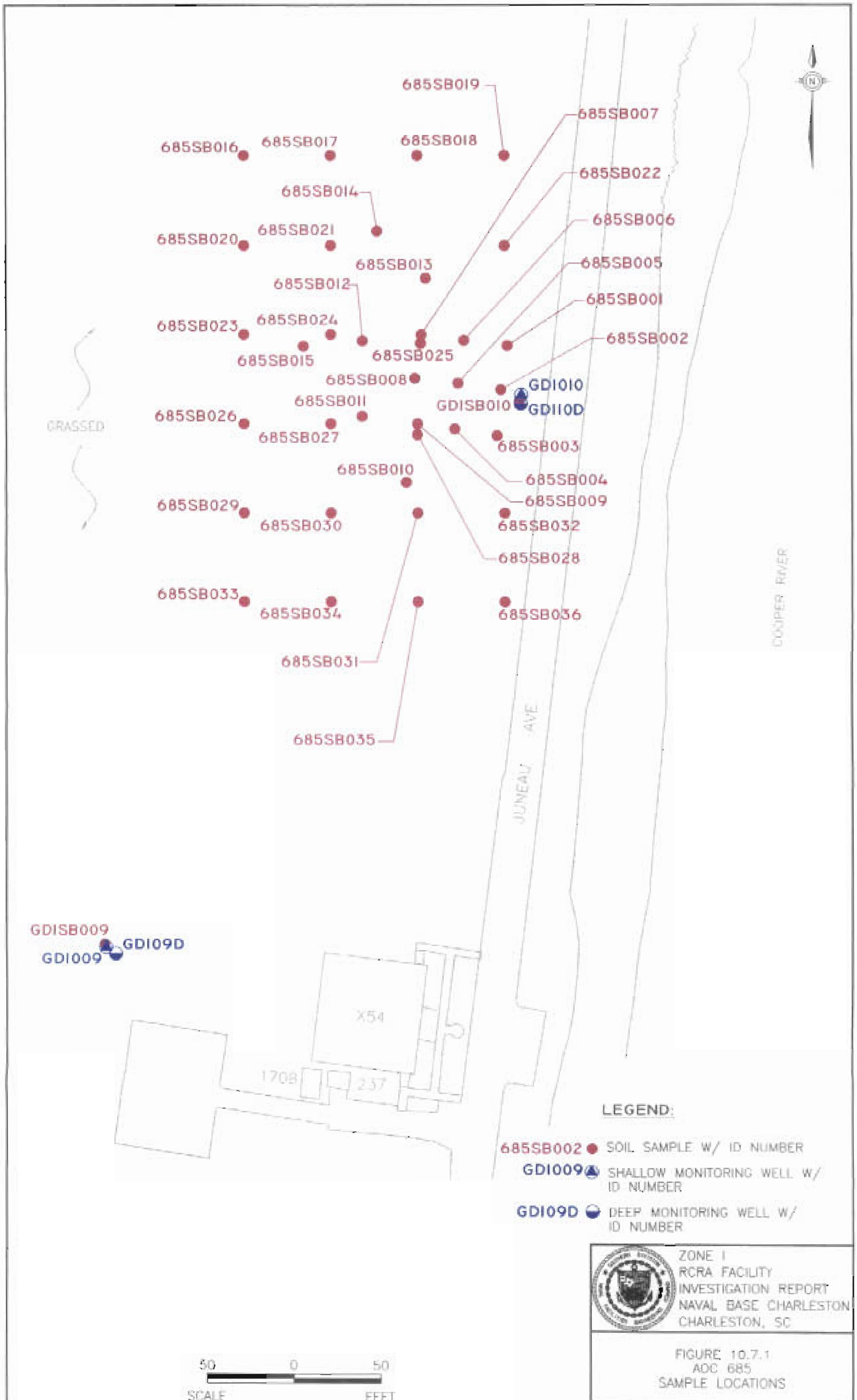
Second-round sampling was performed following a comparison of first-round analytical results to the USEPA Region III RBCs. The comparison showed that several samples had concentrations exceeding the RBCs for benzo(a)pyrene, and that several metal concentrations exceeded their respective RBC or background concentrations. This justified the collection of six second-round upper-interval soil samples for analysis of SVOCs and metals. One second-round duplicate sample was submitted for Appendix IX parameters and TPH GRO/DRO at DQO Level IV. Third-round sampling was also performed, with 21 upper- and 18 lower-interval samples taken and analyzed for metals and SVOCs analyses. Three third-round duplicate samples were analyzed for metals and SVOCS. The third-round lower-interval samples were collected below the groundwater table to help in assessing the potential for groundwater contamination. The three rounds of soil sampling are summarized in Table 10.7.1.

10.7.2 Nature and Extent of Contamination in Soil

Organic compound analytical data for soil are summarized in Table 10.7.2. Table 10.7.3 summarizes inorganic compound analytical results for soil. Table 10.7.4 summarizes all analytes detected in surface and subsurface soil at AOC 685. Appendix D contains a complete analytical data report for all samples collected in Zone I.

Volatile Organic Compounds in Soil

Three VOCs - acetone, Freon 113, and toluene - were detected in surface soil samples at AOC 685 far below their respective RBCs.



ZONE I
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.7.1
AOC 685
SAMPLE LOCATIONS

Table 10.7.1
AOC 685
Soil Sampling Summary

Sampling Round	Sampling Date	Samples Collected	Sample Analyses	Comments
1	02/22/95	Upper - 9 (9)	Organotins, Standard Suite, Additional Parameters[a]	
		Lower - 0 (9)		No lower-interval samples were collected due to a water table at less than 5 ft bgs
		Duplicate - 1	Appendix IX	
2	06/20/95	Upper - 6	Metals, SVOCs	Samples collected to delineate the nature and extent of SVOCs and metals detected above RBCs and/or background.
		Duplicate - 1	Appendix IX, TPH GRO/DRO	
3	03/31/98 04/01/98	Upper - 21	Metals, SVOCs	Lower-intervals samples collected below water table for use in assessing groundwater contamination.
		Lower - 18	Metals, SVOCs	
		Duplicate - 3	Metals, SVOCs	

Notes:

( ) = Parenthesis indicate number of samples proposed in the final RFI work plan.
a = Additional analysis performed on one sample on 09/07/95 included CEC, chloride, sulfur, ammonia, nitrate/nitrite, phosphorus, TOC, and total moisture. This sample was also extracted using the TCLP and the extract was analyzed for VOCS, SVOCs, and metals.
Standard Suite = VOCs, SVOCs, metals, cyanide, pesticides, and PCBs at DQO Level III.

Table 10.7.2
AOC 685
Organic Compound Analytical Results for Soil (μg/kg)

Parameter	Sample Interval	Detection Frequency	Detection Range	Mean	RBC (upper) SSL (lower)	Number of Samples Exceeding RBC or SSL
Volatile Organic Compounds						
Acetone	Upper	2/10	26.0 - 36.0	31.0	780,000	0
	Lower	0/0	NA	NA	8,000	0
Trichlorotrifluoroethane (Freon 113)	Upper	2/10	4.0 - 15.0	9.5	230,000,000	0
	Lower	0/0	NA	NA	NA	NA
Toluene	Upper	4/10	1.0 - 6.0	3.75	1,600,000	0
	Lower	0/0	NA	NA	6,000	0
Semivolatile Organic Compounds						
BEQ	Upper	23/36	2.92 - 3746	290	87	15
	Lower	7/18	1.72 - 104	37	1,600	0
Benzo(a)anthracene	Upper	22/36	26.0 - 2,000	192	870	1
	Lower	3/18	17.0 - 51.0	36.7	800	0
Benzo(a)pyrene	Upper	21/36	33.0 - 2,700	235	87	14
	Lower	4/18	35.0 - 88.0	52.8	4,000	0
Benzo(b)fluoranthene	Upper	22/36	29.0 - 3,400	321	870	1
	Lower	5/18	46.0 - 150	73.8	2,500	0
Benzo(k)fluoranthene	Upper	20/36	26.0 - 1,400	226	8,700	0
	Lower	1/18	48.0	48.0	25,000	0
Chrysene	Upper	23/36	18.0 - 2,200	207	87,000	0
	Lower	6/18	18.0 - 100	47.3	80,000	0
Dibenz(a,h)anthracene	Upper	1/36	340	340	87	1
	Lower	0/36	ND	ND	800	0
Indeno(1,2,3-cd)pyrene	Upper	8/36	32.0 - 1,500	254	870	1
	Lower	0/18	ND	ND	7,000	0
2-Methylnaphthalene	Upper	3/36	15.0 - 34.0	24.0	310,000	0
	Lower	0/18	ND	ND	230,000	0
3-Methylphenol (m-cresol)	Upper	1/15	160.0	160	390,000	0
	Lower	0/0	ND	ND	6,700	0
4-Methylphenol (p-cresol)	Upper	1/36	160	160	39,000	0
	Lower	0/18	ND	ND	670	0
Acenaphthene	Upper	3/36	20.0 - 160	68.0	470,000	0
	Lower	0/18	ND	ND	290,000	0

Table 10.7.2
AOC 685
Organic Compound Analytical Results for Soil (μg/kg)

Parameter	Sample Interval	Detection Frequency	Detection Range	Mean	RBC (upper) SSL (lower)	Number of Samples Exceeding RBC or SSL
Anthracene	Upper	6/36	19.0 - 200	62.0	2,300,000	0
	Lower	0/18	ND	ND	5,900,000	0
Benzo(g,h,i)perylene	Upper	8/36	31.0 - 1300	236	310,000	0
	Lower	1/18	33.0	33.0	120,000,000	0
Butylbenzylphthalate	Upper	1/36	61.0	61.0	1,600,000	0
	Lower	0/18	ND	ND	930,000	0
Dibenzofuran	Upper	1/36	49.0	49.0	31,000	0
	Lower	0/18	ND	ND	6,800	0
Fluoranthene	Upper	23/36	18.0 - 2,600	271	310,000	0
	Lower	5/18	26.0 - 220	77.2	2,100,000	0
Fluorene	Upper	2/36	22.0 - 80.0	51.0	310,000	0
	Lower	0/18	ND	ND	280,000	0
Naphthalene	Upper	4/36	28.0 - 100	55.8	310,000	0
	Lower	0/18	ND	ND	42,000	0
Pentachlorophenol	Upper	1/36	45.0	45.0	5,300	0
	Lower	0/18	ND	ND	13	0
Phenanthrene	Upper	20/36	34.0 - 1,000	152	230,000	0
	Lower	1/18	33.0	33.0	660,000	0
Pyrene	Upper	26/36	17.0 - 2,800	247	230,000	0
	Lower	7/18	25.0 - 320	117	2,100,000	0
bis(2-Ethylhexyl)phthalate (BEHP)	Upper	9/36	57.0 - 930	251	46,000	0
	Lower	1/18	150	150	1,800,000	0
TPH-GRO						
Gasoline	Upper	1/1	4,800	4,800	NA	NA
	Lower	0/0	NA	NA	NA	NA
Herbicides						
2,4-D	Upper	1/2	28.0	28.0	78,000	0
	Lower	0/0	NA	NA	370	0
2,4,5-T	Upper	1/2	8.1	8.1	78,000	0
	Lower	0/0	NA	NA	370	0
2,4,5-TP (Silvex)	Upper	1/2	2.1	2.1	63,000	0
	Lower	0/0	NA	NA	5,600	0

Table 10.7.2
AOC 685
Organic Compound Analytical Results for Soil (μg/kg)

Parameter	Sample Interval	Detection Frequency	Detection Range	Mean	RBC (upper) SSL (lower)	Number of Samples Exceeding RBC or SSL
Pesticides and PCBs						
4,4'-DDD	Upper	7/10	6.3 - 36.0	14.6	2,700	0
	Lower	0/0	NA	NA	8,000	0
4,4'-DDE	Upper	7/10	8.4 - 220	65.4	1,900	0
	Lower	0/0	NA	NA	27,000	0
4,4'-DDT	Upper	7/10	0.53 - 53.0	18.3	1,900	0
	Lower	0/0	NA	NA	16,000	0
Aldrin	Upper	1/10	1.7	1.7	38	0
	Lower	0/0	NA	NA	230	0
Chlordane	Upper	1/10	54.0	54.0	1,800	0
	Lower	0/0	NA	NA	5,000	0
Dieldrin	Upper	1/10	1.3	1.3	40	0
	Lower	0/0	NA	NA	2	0
Endosulfan I	Upper	5/10	0.35 - 8.3	3.1	47,000	0
	Lower	0/0	NA	NA	9,000	0
Endosulfan Sulfate	Upper	1/10	0.36	0.36	47,000	0
	Lower	0/0	NA	NA	4,600	0
Endrin	Upper	1/10	1.2	1.2	2,300	0
	Lower	0/0	NA	NA	500	0
Endrin Aldehyde	Upper	8/10	1.4 - 8.9	3.7	2,300	0
	Lower	0/0	NA	NA	340	0
Heptachlor epoxide	Upper	5/10	2.6 - 49.0	15.1	70	0
	Lower	0/0	NA	NA	330	0
Methoxychlor	Upper	3/10	1.9 - 5.0	3.9	39,000	0
	Lower	0/0	NA	NA	80,000	0
delta-BHC	Upper	1/10	0.41	0.41	350	0
	Lower	0/0	NA	NA	1.8	0
gamma-BHC	Upper	1/10	1.4	1.4	490	0
	Lower	0/0	NA	NA	4.5	0
Dioxin Compounds and Organotins						
TEQ	Upper	2/2	1.30E-4 - 5.40E-4	3.40E-4	4.3E-03	0
	Lower	0/0	NA	NA	1.6	0

Table 10.7.2
AOC 685
Organic Compound Analytical Results for Soil (µg/kg)

Parameter	Sample Interval	Detection Frequency	Detection Range	Mean	RBC (upper) SSL (lower)	Number of Samples Exceeding RBC or SSL
1,2,3,4,6,7,8-HpCDD	Upper	2/2	5.35E-3 - 2.04E-2	1.29E-2	0.43	0
	Lower	0/0	NA	NA	108	0
1,2,3,4,6,7,8-HpCDF	Upper	2/2	8.78E-4 - 4.75E-3	2.82E-3	0.43	0
	Lower	0/0	NA	NA	54	0
1,2,3,6,7,8-HxCDF	Upper	1/2	9.58E-4	9.58E-04	0.043	0
	Lower	0/0	NA	NA	216	0
OCDD	Upper	2/2	7.02E-2 - 0.18	0.13	4.3	0
	Lower	0/0	NA	NA	1,080	0
OCDF	Upper	2/2	1.27E-3 - 7.74E-3	4.50E-3	4.3	0
	Lower	0/0	NA	NA	540	0

Notes:
µg/kg = micrograms per kilograms
NA = Not Applicable/Not Available/Not Analyzed
ND = Not Detected

Table 10.7.3
AOC 685
Inorganic Compound Analytical Results for Soil (mg/kg)

Parameter	Sample Interval	Detection Frequency	Detection Range	Mean	Background Concentration	RBC (upper) SSL (lower)	Number of Samples Exceeding: RBC & Background (upper) or SSL & Background (lower)
Aluminum (Al)	Upper	36/36	8,350 - 29,900	17,968	27,400	7800	3
	Lower	18/18	8,530 - 40,300	26,329	18,900	560,000	0
Antimony (Sb)	Upper	9/36	0.44 - 21.4	3.9	ND	3.1	3
	Lower	0/18	ND	ND	ND	2.7	0
Arsenic (As)	Upper	36/36	5.5 - 30.3	11.9	21.6	0.43	1
	Lower	18/18	6.2 - 30.6	16.4	6.45	15	13
Barium (Ba)	Upper	36/36	15.7 - 54.4	33.6	54.2	550	0
	Lower	18/18	17.5 - 57.6	36.2	36	820	0
Beryllium (Be)	Upper	31/36	0.55 - 1.4	0.90	0.95	16	0
	Lower	17/18	0.41 - 1.7	1.3	0.67	32	0
Cadmium (Cd)	Upper	11/36	0.07 - 0.97	0.38	0.61	7.8	0
	Lower	7/18	0.05 - 0.60	0.25	0.54	4	0
Calcium (Ca)	Upper	36/36	21,200 - 114,000	48,000	NL	NL	0
	Lower	18/18	6,520 - 134,000	39,340	NL	NL	0
Chromium (Cr)(Total)	Upper	36/36	16.5 - 83.5	44.2	34.5	39	23
	Lower	18/18	16.8 - 85.7	54.4	51.3	19	13
Cobalt (Co)	Upper	36/36	1.8 - 7.4	4.9	5.8	470	0
	Lower	18/18	1.9 - 10.1	6.7	3.48	990	0
Copper (Cu)	Upper	36/36	13.4 - 494	121	240	310	4
	Lower	18/18	7.3 - 45.9	27.1	11.5	5600	0
Iron (Fe)	Upper	36/36	8,320 - 41,500	18,303	NL	NL	0
	Lower	18/18	8,220 - 47,700	29,954	NL	NL	0

Table 10.7.3
AOC 685
Inorganic Compound Analytical Results for Soil (mg/kg)

Parameter	Sample Interval	Detection Frequency	Detection Range	Mean	Background Concentration	RBC (upper) SSL (lower)	Number of Samples Exceeding: RBC & Background (upper) or SSL & Background (lower)
Lead (Pb)	Upper	36/36	19.5 - 1110	179	203	400	4
	Lower	18/18	9.2 - 35.4	26.7	12.3	400	0
Magnesium (Mg)	Upper	36/36	2,010 - 6,690	4,053	NL	NL	0
	Lower	18/18	2,560 - 8,250	6,067	NL	NL	0
Manganese (Mn)	Upper	36/36	128 - 1920	514	419	160	16
	Lower	18/18	62.2 - 3460	553	118	480	5
Mercury (Hg)	Upper	29/36	0.03 - 0.21	0.12	0.47	2.3	0
	Lower	18/18	0.02 - 0.27	0.15	ND	1	0
Nickel (Ni)	Upper	36/36	6.50 - 54.90	21.31	23.9	160	0
	Lower	18/18	7.60 - 30.80	18.12	15.7	65	0
Potassium (K)	Upper	36/36	719 - 3,000	1,562	NL	NL	0
	Lower	18/18	593 - 3,650	2,522	NL	NL	0
Selenium (Se)	Upper	11/36	0.58 - 2.1	1.00	1.49	39	0
	Lower	1/18	0.68	0.68	1.77	2.6	0
Sodium (Na)	Upper	36/36	501 - 4,140	1,112	NL	NL	0
	Lower	18/18	484 - 5,160	2,480	NL	NL	0
Tin (Sn)	Upper	26/36	1.2 - 42.0	12.0	7.5	4,700	0
	Lower	8/18	2.0 - 5.1	3.2	ND	5,500	0
Thallium (Tl)	Upper	1/36	0.71	0.71	ND	0.55	1
	Lower	0/18	ND	ND	ND	0.36	0
Vanadium (V)	Upper	30/36	18.7 - 74.5	44.1	113	55	0
	Lower	18/18	21.1 - 90.9	66.2	38.1	3000	0

Table 10.7.3
AOC 685
Inorganic Compound Analytical Results for Soil (mg/kg)

Parameter	Sample Interval	Detection Frequency	Detection Range	Mean	Background Concentration	RBC (upper) SSL (lower)	Number of Samples Exceeding: RBC & Background (upper) or SSL & Background (lower)
Zinc (Zn)	Upper	36/36	30.1 - 876	202	206	2300	0
	Lower	18/18	37.5 - 118	85.5	36.2	6200	0

Notes:
ND = Not Detected/Not Determined
NL = Not Listed
mg/kg = milligrams per kilogram
See Table 5.6 for inorganic element screening concentrations.

Table 10.7.4
AOC 685
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Volatile Organic Compounds ($\mu g/kg$)							
Acetone	685SB001	26	780000	NA	NT	8000	NA
	685SB007	36			NT		
Toluene	685SB005	1	1600000	NA	NT	6000	NA
	685SB006	6			NT		
	685SB007	3			NT		
	685SB009	5			NT		
Trichlorotrifluoroethane (Freon 113)	685SB002	4	230000000	NA	NT	NA	NA
	685SB009	15			NT		
Semivolatile Organic Compounds ($\mu g/kg$)							
Acenaphthene	685SB017	24	470000	NA	ND	290000	NA
	685SB025	160			NT		
	685SB036	20			ND		
Anthracene	685SB009	43	2300000	NA	NT	5900000	NA
	685SB017	37			ND		
	685SB021	19			ND		
	685SB025	200			NT		
	685SB030	25			ND		
	685SB036	48			ND		

Table 10.7.4
AOC 685
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Benzo(g,h,i)perylene	685SB014	150	310000	NA	NT	1.2e+08	NA
	685SB017	110			ND		
	685SB021	120			ND		
	685SB025	1300			NT		
	685SB027	31			ND		
	685SB028	78			NT		
	685SB030	52			ND		
	685SB036	45			33		
Benzo(a)pyrene Equivalents (BEQs)	685SB005	59.4	87	NA	NT	1600	NA
	685SB006	5.45			NT		
	685SB007	298			NT		
	685SB008	149			NT		
	685SB009	277			NT		
	685SB010	177			NT		
	685SB011	90			NT		
	685SB012	132			NT		
	685SB013	134			NT		
	685SB014	164			NT		
	685SB015	81.5			NT		
	685SB017	263			45.5		
	685SB018	42.3			ND		
	685SB019	68.9			53.1		

Table 10.7.4
AOC 685
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Benzo(a)pyrene Equivalents (BEQs)	685SB021	202			1.72		
(Continued)	685SB023	2.92			ND		
	685SB025	3746			NT		
	685SB027	72.4			4.63		
	685SB028	175			NT		
	685SB030	138			4		
	685SB031	61.7			104		
	685SB032	171			ND		
	685SB036	150			47.1		
Benzo(a)anthracene	685SB005	82	870	NA	NT	800	NA
	685SB006	54			NT		
	685SB007	200			NT		
	685SB008	130			NT		
	685SB009	280			NT		
	685SB010	130			NT		
	685SB011	81			NT		
	685SB012	90			NT		
	685SB013	84			NT		
	685SB014	120			NT		
	685SB015	52			NT		
	685SB017	140			42		

Table 10.7.4
AOC 685
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Benzo(a)anthracene (Continued)	685SB018	26			ND		
	685SB019	53			ND		
	685SB021	110			17		
	685SB025	2000			NT		
	685SB027	54			ND		
	685SB028	130			NT		
	685SB030	110			ND		
	685SB031	38			ND		
	685SB032	120			ND		
	685SB036	150			51		
Benzo(a)pyrene	685SB005	40	87	NA	NT	4000	NA
	685SB007	230			NT		
	685SB008	110			NT		
	685SB009	200			NT		
	685SB010	140			NT		
	685SB011	62			NT		
	685SB012	100			NT		
	685SB013	110			NT		
	685SB014	120			NT		
	685SB015	67			NT		
	685SB017	210			35		

Table 10.7.4
AOC 685
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Benzo(a)pyrene (Continued)	685SB018	33			ND		
	685SB019	52			46		
	685SB021	160			ND		
	685SB025	2700			NT		
	685SB027	54			ND		
	685SB028	140			NT		
	685SB030	110			ND		
	685SB031	50			88		
	685SB032	140			ND		
	685SB036	110			42		
Benzo(b)fluoranthene	685SB005	100	870	NA	NT	2500	NA
	685SB007	430			NT		
	685SB008	230			NT		
	685SB009	440			NT		
	685SB010	220			NT		
	685SB011	180			NT		
	685SB012	210			NT		
	685SB013	140			NT		
	685SB014	220			NT		
	685SB015	84			NT		
	685SB017	260			62		

Table 10.7.4
AOC 685
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Benzo(b)fluoranthene (Continued)	685SB018	64			ND		
	685SB019	83			71		
	685SB021	180			ND		
	685SB023	29			ND		
	685SB025	3400			NT		
	685SB027	90			46		
	685SB028	120			NT		
	685SB030	160			40		
	685SB031	75			150		
	685SB032	170			ND		
	685SB036	180			ND		
Benzo(k)fluoranthene	685SB005	110	8700	NA	NT	25000	NA
	685SB007	470			NT		
	685SB008	250			NT		
	685SB009	480			NT		
	685SB010	220			NT		
	685SB011	190			NT		
	685SB012	230			NT		
	685SB013	150			NT		
	685SB014	210			NT		
	685SB015	86.5			NT		

Table 10.7.4
AOC 685
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Benzo(k)fluoranthene (Continued)	685SB017	100			ND		
	685SB018	26			ND		
	685SB021	61			ND		
	685SB025	1400			NT		
	685SB027	30			ND		
	685SB028	130			NT		
	685SB030	62			ND		
	685SB031	32			48		
	685SB032	180			ND		
	685SB036	110.5			ND		
Chrysene	685SB005	57	87000	NA	NT	80000	NA
	685SB006	58			NT		
	685SB007	260			NT		
	685SB008	140			NT		
	685SB009	290			NT		
	685SB010	150			NT		
	685SB011	80			NT		
	685SB012	120			NT		
	685SB013	100			NT		
	685SB014	130			NT		
	685SB015	54			NT		

Table 10.7.4
AOC 685
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Chrysene (Continued)	685SB017	150			47		
	685SB018	32			ND		
	685SB019	58			43		
	685SB021	140			18		
	685SB023	18			ND		
	685SB025	2200			NT		
	685SB027	71			31		
	685SB028	150			NT		
	685SB030	140			ND		
	685SB031	48			100		
	685SB032	160			ND		
	685SB036	160			45		
Dibenz(a,h)anthracene	685SB025	340	87	NA	NT	800	NA
Indeno(1,2,3-cd)pyrene	685SB014	81	870	NA	NT	7000	NA
	685SB017	120			ND		
	685SB019	32			ND		
	685SB021	120			ND		
	685SB025	1500			NT		
	685SB027	36			ND		
	685SB028	88			NT		
	685SB036	53			ND		

Table 10.7.4
AOC 685
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Butylbenzylphthalate	685SB015	61	1600000	NA	NT	930000	NA
Dibenzofuran	685SB025	49	31000	NA	NT	6800	NA
bis(2-Ethylhexyl)phthalate (BEHP)	685SB001	57	46000	NA	NT	1800000	NA
	685SB007	120			NT		
	685SB010	210			NT		
	685SB011	110			NT		
	685SB012	94			NT		
	685SB013	95			NT		
	685SB014	540			NT		
	685SB015	99			NT		
	685SB020	ND			150		
	685SB024	930			NT		
Fluoranthene	685SB005	100	310000	NA	NT	2100000	NA
	685SB006	90			NT		
	685SB007	300			NT		
	685SB008	200			NT		
	685SB009	470			NT		
	685SB010	220			NT		
	685SB011	140			NT		
	685SB012	160			NT		
	685SB013	120			NT		

Table 10.7.4
AOC 685
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Fluoranthene (Continued)	685SB014	160			NT		
	685SB015	89			NT		
	685SB017	210			47		
	685SB018	22			ND		
	685SB019	86			60		
	685SB021	150			ND		
	685SB023	18			ND		
	685SB025	2600			NT		
	685SB027	90			26		
	685SB028	210			NT		
	685SB030	210			33		
	685SB031	60			220		
	685SB032	230			ND		
	685SB036	290			ND		
Fluorene	685SB025	80	310000	NA	NT	280000	NA
	685SB036	22			ND		
2-Methylnaphthalene	685SB025	34	310000	NA	NT	230000	NA
	685SB030	23			ND		
	685SB031	15			ND		
3-Methylphenol (m-cresol)	685SB009	160	390000	NA	NT	6700	NA
4-Methylphenol (p-cresol)	685SB009	160	39000	NA	NT	670	NA

Table 10.7.4
AOC 685
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Naphthalene	685SB009	52	310000	NA	NT	42000	NA
	685SB010	43			NT		
	685SB025	100			NT		
	685SB030	28			ND		
Pentachlorophenol	685SB014	45	5300	NA	NT	13	NA
Phenanthrene	685SB005	60	230000	NA	NT	660000	NA
	685SB006	63			NT		
	685SB007	180			NT		
	685SB008	120			NT		
	685SB009	220			NT		
	685SB010	140			NT		
	685SB011	79			NT		
	685SB012	75			NT		
	685SB013	51			NT		
	685SB014	110			NT		
	685SB017	150			ND		
	685SB019	49			ND		
	685SB021	79			ND		
	586SB025	1000			NT		
	685SB027	62			ND		
	685SB028	110			NT		

Table 10.7.4
AOC 685
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Phenanthrene (Continued)	685SB030	120			ND		
	685SB031	34			33		
	685SB032	110			ND		
	685SB036	235			ND		
Pyrene	685SB005	84	230000	NA	NT	2100000	NA
	685SB006	80			NT		
	685SB007	260			NT		
	685SB008	160			NT		
	685SB009	390			NT		
	685SB010	170			NT		
	685SB011	130			NT		
	685SB012	130			NT		
	685SB013	100			NT		
	685SB014	180			NT		
	685SB015	92			NT		
	685SB016	26			ND		
	685SB017	290			60		
	685SB018	28			ND		
	685SB019	78			110		
	685SB021	150			ND		
	685SB022	25			25		

Table 10.7.4
AOC 685
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Pyrene (Continued)	685SB023	17			ND		
	685SB024	100			NT		
	685SB025	2800			NT		
	685SB027	110			26		
	685SB028	210			NT		
	685SB030	230			36		
	685SB031	60			240		
	685SB032	230			ND		
	685SB036	230			320		
Pesticides and PCBs (µg/kg)							
Aldrin	685SB008	1.7	38	NA	NT	230	NA
delta-BHC (delta-HCH.)	685SB015	0.41	350	NA	NT	1.8	NA
gamma-BHC (Lindane)	685SB005	1.4	490	NA	NT	4.5	NA
Chlordane	685SB015	54	1800	NA	NT	5000	NA
4,4'-DDD	685SB002	6.3	2700	NA	NT	8000	NA
	685SB005	12			NT		
	685SB006	17			NT		
	685SB007	11			NT		
	685SB008	36			NT		
	685SB009	8.9			NT		
	685SB015	11			NT		

Table 10.7.4
AOC 685
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
4,4'-DDE	685SB001	23	1900	NA	NT	27000	NA
	685SB002	110			NT		
	685SB004	28.5			NT		
	685SB006	220			NT		
	685SB007	8.4			NT		
	685SB008	58			NT		
	685SB009	10			NT		
4,4'-DDT	685SB001	10	1900	NA	NT	16000	NA
	685SB002	53			NT		
	685SB003	5.3			NT		
	685SB004	15.15			NT		
	685SB006	32			NT		
	685SB007	12			NT		
	685SB015	0.53			NT		
Dieldrin	685SB015	1.3	40	NA	NT	2	NA
Endosulfan I	685SB005	2.5	47000	NA	NT	9000	NA
	685SB007	8.3			NT		
	685SB008	2.3			NT		
	685SB009	1.9			NT		
	685SB015	0.35			NT		
Endosulfan sulfate	685SB015	0.36	47000'	NA	NT	4600	NA

Table 10.7.4
AOC 685
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Endrin	685SB015	1.2	2300	NA	NT	500	NA
Endrin aldehyde	685SB001	1.4	2300	NA	NT	340	NA
	685SB002	1.4			NT		
	685SB003	1.5			NT		
	685SB004	5.1			NT		
	685SB005	2.9			NT		
	685SB008	4			NT		
	685SB009	8.9			NT		
	685SB015	4.3			NT		
Heptachlor epoxide	685SB002	17	70	NA	NT	330	NA
	685SB004	3.2			NT		
	685SB005	3.9			NT		
	685SB006	49			NT		
	685SB015	2.6			NT		
Methoxychlor	685SB004	5	39000	NA	NT	80000	NA
	685SB008	4.9			NT		
	685SB015	1.9			NT		
Herbicides (μg/kg)							
2,4-D	685SB004	28	78000	NA	NT	370	NA
2,4,5-T	685SB015	8.1	78000	NA	NT	990	NA
2,4,5-TP (Silvex)	685SB015	2.1	63000	NA	NT	5600	NA

Table 10.7.4
AOC 685
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
TPH (mg/kg)							
Petroleum hydrocarbons, TPH	685SB015	4.8	NA	NA	NT	NA	NA
Dioxin Compounds (ng/kg)							
2,3,7,8-TCDD equivalents (TEQs)	685SB004	0.1337	4.3	NA	NT	1600	NA
	685SB015	0.53755			NT		
1234678-HpCDD	685SB004	5.35	430	NA	NT	108000	NA
	685SB015	20.374			NT		
OCDD	685SB004	70.156	4300	NA	NT	1080000	NA
	685SB015	182.703			NT		
123678-HxCDF	685SB015	0.958	43	NA	NT	216000	NA
1234678-HpCDF	685SB004	0.878	430	NA	NT	54000	NA
	685SB015	4.757			NT		
OCDF	685SB004	1.267	4300	NA	NT	540000	NA
	685SB015	7.735			NT		
Inorganics (mg/kg)							
Aluminum (Al)	685SB001	15300	7800	27400	NT	560000	18900
	685SB002	23500			NT		
	685SB003	29900			NT		
	685SB004	20900			NT		
	685SB005	12400			NT		
	685SB006	22000			NT		
	685SB007	23200			NT		

Table 10.7.4
AOC 685
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Aluminum (Al) (Continued)	685SB008	14000			NT		
	685SB009	14600			NT		
	685SB010	12400			NT		
	685SB011	10900			NT		
	685SB012	10300			NT		
	685SB013	13500			NT		
	685SB014	13200			NT		
	685SB015	17450			NT		
	685SB016	16400			31800		
	685SB017	28700			27900		
	685SB018	22500			16600		
	685SB019	8350			22500		
	685SB020	24200			31600		
	685SB021	25700			26400		
	685SB022	23900			18200		
	685SB023	15000			31600		
	685SB024	19600			NT		
	685SB025	17300			NT		
	685SB026	25100			32600		
	685SB027	13900			22900		
	685SB028	10900			NT		

Table 10.7.4
AOC 685
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Aluminum (Al) (Continued)	685SB029	24900			35700		
	685SB030	10800			30100		
	685SB031	20700			40300		
	685SB032	10700			8530		
	685SB033	29000			29800		
	685SB034	15900			35300		
	685SB035	19700			21200		
	685SB036	10050			10900		
Antimony (Sb)	685SB009	21.4	3.1	ND	NT	2.7	ND
	685SB010	1			NT		
	685SB011	0.88			NT		
	685SB012	0.94			NT		
	685SB013	0.6			NT		
	685SB014	0.44			NT		
	685SB015	0.775			NT		
	685SB030	3.2			ND		
Arsenic (As)	685SB001	20.7	0.43	21.6	NT	15	6.45
	685SB002	11.8			NT		
	685SB003	15.5			NT		
	685SB004	9.2			NT		
	685SB005	6.2			NT		

Table 10.7.4
AOC 685
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Arsenic (As) (Continued)	685SB006	14.8			NT		
	685SB007	10			NT		
	685SB008	9.6			NT		
	685SB009	7.1			NT		
	685SB010	10.9			NT		
	685SB011	6.8			NT		
	685SB012	5.5			NT		
	685SB013	7.8			NT		
	685SB014	5.9			NT		
	685SB015	7.25			NT		
	685SB016	10.4			11.3		
	685SB017	14.6			20.4		
	685SB018	13.1			8.1		
	685SB019	5.5			16.1		
	685SB020	10.1			19.8		
	685SB021	14			16.75		
	685SB022	18.5			13.2		
	685SB023	12.9			18.5		
	685SB024	10.4			NT		
	685SB025	11.8			NT		
	685SB026	20.7			17.9		

Table 10.7.4
AOC 685
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Arsenic (As) (Continued)	685SB027	9.1			17		
	685SB028	10.3			NT		
	685SB029	30.3			20.15		
	685SB030	10.6			17.8		
	685SB031	15.1			18.8		
	685SB032	12.1			6.2		
	685SB033	14.4			30.6		
	685SB034	14.4			16.2		
	685SB035	12.4			19.1		
	685SB036	8.9			6.4		
Barium (Ba)	685SB001	41.7	550	54.2	NT	820	36
	685SB002	33.8			NT		
	685SB003	35.4			NT		
	685SB004	35.25			NT		
	685SB005	33.2			NT		
	685SB006	37.7			NT		
	685SB007	36.8			NT		
	685SB008	43			NT		
	685SB009	47.7			NT		
	685SB010	26			NT		
	685SB011	22.6			NT		

Table 10.7.4
AOC 685
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Barium (Ba) (Continued)	685SB012	24.5			NT		
	685SB013	26.9			NT		
	685SB014	23.5			NT		
	685SB015	25.05			NT		
	685SB016	26.4			40.3		
	685SB017	36.9			44		
	685SB018	34.1			30.6		
	685SB019	15.7			29.9		
	685SB020	32.2			36.9		
	685SB021	38			38.65		
	685SB022	37.8			27		
	685SB023	20			40.6		
	685SB024	32.2			NT		
	685SB025	33.5			NT		
	685SB026	39.9			39		
	685SB027	28.1			33.9		
	685SB028	33.4			NT		
	685SB029	40.9			42.25		
	685SB030	35.9			36.2		
	685SB031	46.7			46.8		
	685SB032	26.6			17.5		

Table 10.7.4
AOC 685
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Barium (Ba) (Continued)	685SB033	38.4			57.6		
	685SB034	54.4			40.6		
	685SB035	38.5			30.5		
	685SB036	26.35			19.3		
Beryllium (Be)	685SB001	0.86	16	0.95	NT	32	0.67
	685SB002	0.93			NT		
	685SB003	1.2			NT		
	685SB004	1			NT		
	685SB005	0.76			NT		
	685SB006	0.98			NT		
	685SB007	0.93			NT		
	685SB008	0.99			NT		
	685SB009	0.97			NT		
	685SB010	0.55			NT		
	685SB013	0.56			NT		
	685SB014	0.56			NT		
	685SB015	0.69			NT		
	685SB016	0.82			1.5		
	685SB017	1.1			1.4		
	685SB018	0.99			0.91		
	685SB019	ND			1.1		

Table 10.7.4
AOC 685
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Beryllium (Be) (Continued)	685SB020	1.1			1.5		
	685SB021	1			1.3		
	685SB022	1.1			0.91		
	685SB023	0.76			1.4		
	685SB024	0.84			NT		
	685SB025	0.81			NT		
	685SB026	1.2			1.5		
	685SB027	0.67			1.2		
	685SB028	0.67			NT		
	685SB029	1.3			1.55		
	685SB030	0.66			1.4		
	685SB031	1			1.7		
	685SB033	1.4			1.5		
	685SB034	0.78			1.4		
	685SB035	0.85			1.2		
	685SB036	ND			0.41		
Cadmium (Cd)	685SB001	0.74	7.8	0.61	NT	4	0.54
	685SB008	0.88			NT		
	685SB009	0.97			NT		
	685SB016	ND			0.15		
	685SB018	ND			0.6		

Table 10.7.4
AOC 685
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Cadmium (Cd) (Continued)	685SB020	ND			0.43		
	685SB022	ND			0.3		
	685SB025	0.07			NT		
	685SB027	0.1			0.05		
	685SB028	0.16			NT		
	685SB030	0.13			0.09		
	685SB031	0.68			ND		
	685SB032	0.09			0.05		
	685SB034	0.12			0.14		
	685SB035	0.28			ND		
Chromium (Cr) (total)	685SB001	51.6	39	34.5	NT	19	51.3
	685SB002	47.9			NT		
	685SB003	56.8			NT		
	685SB004	48.4			NT		
	685SB005	34.1			NT		
	685SB006	47			NT		
	685SB007	45			NT		
	685SB008	44.4			NT		
	685SB009	78			NT		
	685SB010	32.4			NT		
	685SB011	58.4			NT		

Table 10.7.4
AOC 685
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Chromium (Cr) (total) (Continued)	685SB012	83.5			NT		
	685SB013	29.1			NT		
	685SB014	27.7			NT		
	685SB015	37.1			NT		
	685SB016	39.7			73.2		
	685SB017	53			85.7		
	685SB018	43.2			43.1		
	685SB019	16.5			33.6		
	685SB020	49.9			74.1		
	685SB021	50			56.05		
	685SB022	46.7			51.5		
	685SB023	34.1			56.4		
	685SB024	53.5			NT		
	685SB025	42.4			NT		
	685SB026	50.5			60.9		
	685SB027	34.9			52.2		
	685SB028	30.5			NT		
	685SB029	55.2			64.1		
	685SB030	33.6			56.9		
	685SB031	49.6			67.3		
	685SB032	25.7			16.8		

Table 10.7.4
AOC 685
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Chromium (Cr) (total) (Continued)	685SB033	58.2			54.7		
	685SB034	35.3			64.8		
	685SB035	47.5			46.7		
	685SB036	20.8			21.2		
Cobalt (Co)	685SB001	3.6	470	5.8	NT	990	3.48
	685SB002	5.3			NT		
	685SB003	6.5			NT		
	685SB004	5.55			NT		
	685SB005	5			NT		
	685SB006	5.9			NT		
	685SB007	6.3			NT		
	685SB008	6.2			NT		
	685SB009	6.3			NT		
	685SB010	2.8			NT		
	685SB011	2.8			NT		
	685SB012	3.3			NT		
	685SB013	2.8			NT		
	685SB014	2.7			NT		
	685SB015	3.45			NT		
	685SB016	4.5			7.6		
	685SB017	6.6			7.6		

Table 10.7.4
AOC 685
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Cobalt (Co) (Continued)	685SB018	5.5			2.9		
	685SB019	1.8			6.7		
	685SB020	5.8			8.4		
	685SB021	5.8			7.3		
	685SB022	6.9			3.4		
	685SB023	4.2			7.9		
	685SB024	5.1			NT		
	685SB025	4.7			NT		
	685SB026	6.6			7.5		
	685SB027	3.9			7		
	685SB028	4			NT		
	685SB029	7.4			8.5		
	685SB030	4			6.8		
	685SB031	6.1			9.7		
	685SB032	2.6			1.9		
	685SB033	7			10.1		
	685SB034	5.2			8		
	685SB035	5.9			7.6		
	685SB036	2.7			2.2		

Table 10.7.4
AOC 685
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Copper (Cu)	685SB001	13.4	310	240	NT	5600	11.5
	685SB002	24.1			NT		
	685SB003	22			NT		
	685SB004	137			NT		
	685SB005	464			NT		
	685SB006	224			NT		
	685SB007	93.3			NT		
	685SB008	494			NT		
	685SB009	483			NT		
	685SB010	102			NT		
	685SB011	60			NT		
	685SB012	172			NT		
	685SB013	21.9			NT		
	685SB014	20			NT		
	685SB015	50.7			NT		
	685SB016	17.3			24.8		
	685SB017	57.5			26.6		
	685SB018	26.3			7.3		
	685SB019	13.8			25.6		
	685SB020	20			25.4		
	685SB021	59.6			45.9		

Table 10.7.4
AOC 685
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Copper (Cu) (Continued)	685SB022	23.2			12.8		
	685SB023	14.6			28.3		
	685SB024	356			NT		
	685SB025	95.2			NT		
	685SB026	24.1			29.5		
	685SB027	94.7			25.2		
	685SB028	308			NT		
	685SB029	25.2			29		
	685SB030	187			27.1		
	685SB031	91.9			32.4		
	685SB032	38.4			17.7		
	685SB033	28.3			28.6		
	685SB034	281			33.7		
	685SB035	195			25.9		
	685SB036	30.35			41.1		

Table 10.7.4
AOC 685
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Lead (Pb)	685SB001	24.3	400	203	NT	400	12.3
	685SB002	29.4			NT		
	685SB003	36.7			NT		
	685SB004	63.2			NT		
	685SB005	306			NT		
	685SB006	178			NT		
	685SB007	167			NT		
	685SB008	459			NT		
	685SB009	949			NT		
	685SB010	105			NT		
	685SB011	88.2			NT		
	685SB012	158			NT		
	685SB013	68.7			NT		
	685SB014	119			NT		
	685SB015	75.6			NT		
	685SB016	25.2			23.7		
	685SB017	332			34.4		
	685SB018	58.3			9.2		
	685SB019	20.9			22.1		
	685SB020	27.3			22.7		
	685SB021	168			35.35		

Table 10.7.4
AOC 685
Analytes Detected in Surface and Subsurface Soil

Parameter		Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Lead (Pb)	(Continued)	685SB022	30.2			15.2		
		685SB023	19.5			30.8		
		685SB024	602			NT		
		685SB025	93.5			NT		
		685SB026	29.9			31.3		
		685SB027	196			30.4		
		685SB028	199			NT		
		685SB029	27.9			28.9		
		685SB030	1110			24.2		
		685SB031	196			33.9		
		685SB032	35.2			22.6		
		685SB033	28.6			31.4		
		685SB034	192			31.2		
		685SB035	180			29.5		
		685SB036	35.7			24.1		

Table 10.7.4
AOC 685
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Manganese (Mn)	685SB001	150	160	419	NT	480	118
	685SB002	276			NT		
	685SB003	222			NT		
	685SB004	217.5			NT		
	685SB005	128			NT		
	685SB006	209			NT		
	685SB007	326			NT		
	685SB008	243			NT		
	685SB009	130			NT		
	685SB010	274			NT		
	685SB011	180			NT		
	685SB012	178			NT		
	685SB013	218			NT		
	685SB014	167			NT		
	685SB015	356			NT		
	685SB016	908			470		
	685SB017	546			647		
	685SB018	465			115		
	685SB019	241			280		
	685SB020	1010			456		
	685SB021	440			901.5		

Table 10.7.4
AOC 685
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Manganese (Mn) (Continued)	685SB022	751			231		
	685SB023	1050			427		
	685SB024	505			NT		
	685SB025	363			NT		
	685SB026	1660			279		
	685SB027	254			534		
	685SB028	231			NT		
	685SB029	1600			377.5		
	685SB030	547			195		
	685SB031	1920			867		
	685SB032	711			62.2		
	685SB033	493			3460		
	685SB034	370			254		
	685SB035	494			290		
	685SB036	665.5			102		

Table 10.7.4
AOC 685
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Mercury (Hg)	685SB001	0.13	2.3	0.47	NT	1	ND
	685SB003	0.18			NT		
	685SB005	0.15			NT		
	685SB006	0.14			NT		
	685SB007	0.21			NT		
	685SB008	0.15			NT		
	685SB011	0.14			NT		
	685SB013	0.12			NT		
	685SB016	0.08			0.11		
	685SB017	0.16			0.21		
	685SB018	0.17			0.02		
	685SB019	0.03			0.03		
	685SB020	0.09			0.12		
	685SB021	0.17			0.155		
	685SB022	0.13			0.05		
	685SB023	0.08			0.27		
	685SB024	0.13			NT		
	685SB025	0.11			NT		
	685SB026	0.15			0.19		
	685SB027	0.12			0.18		
	685SB028	0.1			NT		

Table 10.7.4
AOC 685
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Mercury (Hg) (Continued)	685SB029	0.18			0.165		
	685SB030	0.07			0.12		
	685SB031	0.11			0.21		
	685SB032	0.05			0.04		
	685SB033	0.21			0.27		
	685SB034	0.09			0.25		
	685SB035	0.09			0.2		
	685SB036	0.035			0.11		
Nickel (Ni)	685SB001	17.3	160	23.9	NT	65	15.7
	685SB002	19.5			NT		
	685SB003	22.8			NT		
	685SB004	23.7			NT		
	685SB005	28			NT		
	685SB006	35.2			NT		
	685SB007	17.8			NT		
	685SB008	47.6			NT		
	685SB009	46.8			NT		
	685SB010	18.8			NT		
	685SB011	13			NT		
	685SB012	25.5			NT		
	685SB013	11.7			NT		

Table 10.7.4
AOC 685
Analytes Detected in Surface and Subsurface Soil

Parameter		Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Nickel (Ni)	(Continued)	685SB014	9.3			NT		
		685SB015	14.05			NT		
		685SB016	13.4			23.7		
		685SB017	18.6			16		
		685SB018	16.3			14.1		
		685SB019	6.5			12.3		
		685SB020	17.2			28.7		
		685SB021	17.7			18.8		
		685SB022	19.3			21.9		
		685SB023	12.2			16.6		
		685SB024	15.9			NT		
		685SB025	18.2			NT		
		685SB026	17.9			16.8		
		685SB027	15.2			16.7		
		685SB028	24.2			NT		
		685SB029	15.7			20.9		
		685SB030	29.7			21.4		
		685SB031	22.3			20.8		
		685SB032	11.3			7.6		
		685SB033	16.7			17.5		
		685SB034	54.9			30.8		

Table 10.7.4
AOC 685
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Nickel (Ni) (Continued)	685SB035	40.8			13.8		
	685SB036	12.05			7.8		
Selenium (Se)	685SB001	0.91	39	1.49	NT	2.6	1.77
	685SB002	0.65			NT		
	685SB003	0.71			NT		
	685SB004	1.3			NT		
	685SB006	2.1			NT		
	685SB010	1.1			NT		
	685SB011	0.81			NT		
	685SB012	0.7			NT		
	685SB013	1			NT		
	685SB014	0.58			NT		
	685SB015	1.15			NT		
	685SB036	ND			0.68		
Thallium (Tl)	685SB001	0.71	0.55	ND	NT	0.36	ND
Tin (Sn)	685SB004	9.15	4700	7.5	NT	5500	ND
	685SB005	24.2			NT		
	685SB006	21.5			NT		
	685SB008	42			NT		
	685SB009	39.3			NT		
	685SB010	5.9			NT		

Table 10.7.4
AOC 685
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Tin (Sn) (Continued)	685SB011	3.1			NT		
	685SB012	23.4			NT		
	685SB013	1.8			NT		
	685SB014	1.6			NT		
	685SB015	4.85			NT		
	685SB016	1.5			2		
	685SB017	3.1			2.9		
	685SB018	2.2			ND		
	685SB019	1.5			2		
	685SB021	1.6			2.75		
	685SB023	1.2			3.6		
	685SB024	3			NT		
	685SB025	11.5			NT		
	685SB027	5.9			3		
	685SB028	16.6			NT		
	685SB029	ND			5.1		
	685SB030	22.4			ND		
	685SB031	2.5			4.2		
	685SB034	20.3			ND		
	685SB035	30.9			ND		
	685SB036	9.7			ND		

Table 10.7.4
AOC 685
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Vanadium (V)	685SB001	34	55	113	NT	3000	38.1
	685SB002	42.6			NT		
	685SB003	55.5			NT		
	685SB004	43.4			NT		
	685SB005	25.3			NT		
	685SB006	43.1			NT		
	685SB007	43.9			NT		
	685SB008	30.7			NT		
	685SB009	29.9			NT		
	685SB016	43.9			73.9		
	685SB017	60.1			75.3		
	685SB018	51.7			33.3		
	685SB019	18.7			56.5		
	685SB020	52.5			75.5		
	685SB021	58.1			71.8		
	685SB022	63.1			42.2		
	685SB023	37			78.1		
	685SB024	45.4			NT		
	685SB025	45.5			NT		
	685SB026	61			88.1		
	685SB027	32.9			68.5		

Table 10.7.4
AOC 685
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Vanadium (V) (Continued)	685SB028	32.1			NT		
	685SB029	69			87.1		
	685SB030	28.1			71		
	685SB031	53.8			90.9		
	685SB032	42.7			21.1		
	685SB033	74.5			87.2		
	685SB034	32.5			77.2		
	685SB035	44.7			70.1		
	685SB036	27.55			23.1		
Zinc (Zn)	685SB001	51.6	2300	206	NT	6200	36.2
	685SB002	68.5			NT		
	685SB003	79.7			NT		
	685SB004	213.5			NT		
	685SB005	617			NT		
	685SB006	342			NT		
	685SB007	178			NT		
	685SB008	844			NT		
	685SB009	876			NT		
	685SB010	188			NT		
	685SB011	114			NT		
	685SB012	157			NT		

Table 10.7.4
AOC 685
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Zinc (Zn) (Continued)	685SB013	64.2			NT		
	685SB014	43.5			NT		
	685SB015	83.2			NT		
	685SB016	54.6			99.9		
	685SB017	93.8			83.2		
	685SB018	90.3			37.5		
	685SB019	30.1			113		
	685SB020	65.9			104		
	685SB021	93			118		
	685SB022	75.3			59.9		
	685SB023	49.5			95.9		
	685SB024	114			NT		
	685SB025	321			NT		
	685SB026	80.3			89		
	685SB027	160			86.1		
	685SB028	610			NT		
	685SB029	82.3			100.45		
	685SB030	260			88.7		
	685SB031	179			98.2		
	685SB032	60.5			38.3		
	685SB033	92.3			96		

Table 10.7.4
AOC 685
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Zinc (Zn) (Continued)	685SB034	496			102		
	685SB035	254			76		
	685SB036	77.4			52.1		

Notes:
* = Residential RBCs (THQ=0.1) were used as a reference concentration for upper-interval samples. Generic soil-to-groundwater SSLs (DAF=10) from *Soil Screening Guidance: Technical Background Document* (USEPA, 1996b) were used as a reference concentration for lower-interval samples
All background values for Zone I are based on twice the means of the grid sample concentrations.
DAF = Dilution Attenuation Factor
NA = Not applicable/not available
ND = Not detected
NT = Not taken
RBC = Risk-based concentration
SSL = Soil screening level
THQ = Target Hazard Quotient
ng/kg = Nanograms per kilogram
mg/kg = Micrograms per kilogram
µg/kg = Milligrams per kilogram

Semivolatile Organic Compounds in Soil

Twenty-two SVOCs were detected in surface soils at AOC 685. Five PAHs were detected above their respective RBCs. Four PAHs exceeded their respective RBCs in only one sample (685SB02501): benzo(a)anthracene (2,000 μg/kg), benzo(b)fluoranthene (3,400 μg/kg), dibenz(a,h)anthracene (340 μg/kg), and indeno(1,2,3-cd)pyrene (1,500 μg/kg). Benzo(a)pyrene exceeded its RBC in 21 of 36 surface soil samples, with a maximum detection of 2,700 μg/kg in sample 685SB02501. Ten of the 22 SVOCs detected in surface soils were also detected in subsurface soils. None exceeded their respective RBCs.

In accordance with recent cPAH guidance and Section 7 of this report, BEQs were calculated for samples at AOC 685. BEQs were detected in 22 of 36 surface soil samples and detections ranged from 2.92 μg/kg to 3,746 μg/kg. Concentrations in 15 surface soil samples exceeded the RBC of 87 μg/kg, with the highest detection occurring in sample 685SB02501. BEQs were detected in seven of 18 subsurface soil samples; concentrations ranged from 1.72 μg/kg to 104 μg/kg, below the SSL of 1,600 μg/kg.

Pesticides and PCBs in Soil

Fourteen pesticides and three herbicides were detected in surface soil samples. Each detection was far below the respective RBC.

Other Organic Compounds in Soil

In accordance with recent dioxin guidance and Section 7 of this report, TEQs were calculated for samples from AOC 685. Of the two samples collected for dioxins, neither was above its RBC.

Gasoline was detected at 4,800 μg/kg in the duplicate sample 685SB01501.

Inorganics in Soil

Twenty-three metals were detected in surface soil samples at AOC 685. Seven metals – antimony, arsenic, chromium, copper, lead, manganese, and thallium – were detected at concentrations exceeding their respective RBCs and background levels. Antimony concentrations exceeded the screening criteria in samples 685SB00201 (6.1 mg/kg), 685SB00901 (21.4 mg/kg) and 683SB03001 (3.2 mg/kg). Arsenic was detected in one sample, (685SB02901) at a concentration of 30.3 mg/kg. Twenty-three detections of chromium exceeded the screening criteria, with a maximum concentration of 83.5 mg/kg in 685SB01201. Copper was detected above the screening criteria in samples 685SB00501 (464 mg/kg), 685SB00801 (494 mg/kg), 685SB00901 (483 mg/kg), and 685SB02401 (356 mg/kg). Four samples contained lead above the screening levels: 685SB00801 (459 mg/kg), 685SB00901 (949 mg/kg), 685SB02401 (602 mg/kg), and 685SB030 (1,110 mg/kg). Manganese concentrations that exceeded the RBC and background ranged from 440 mg/kg to 1,920 mg/kg, with a maximum concentration in sample 685SB03101. Thallium was detected in only one sample, 685SB00101 (0.71 mg/kg), which exceeded its RBC.

Twenty-one of the 23 metals detected in surface soils were also detected in subsurface soils. Only three – arsenic, chromium, and manganese – were detected above their respective SSLs and background levels. Thirteen subsurface samples had arsenic concentrations above the screening criteria, with a maximum concentration of 30.6 mg/kg in sample 685SB03302. Chromium exceeded the screening levels in 13 subsurface soil samples, ranging from 51.5 mg/kg (685SB02202) to 85.7 mg/kg (685SB01702). Five subsurface samples had manganese concentrations exceeding its SSL and background; the maximum concentration was detected in sample 685SB03302 (3,460 mg/kg).

10.7.3 Groundwater Sampling and Analysis

No monitoring wells were installed to characterize groundwater at AOC 685. In accordance with the final RFI work plan, a grid-based monitoring well pair, GDI010 and GDI10D, was installed and sampled to characterize the zone perimeter groundwater (see Figure 10.7.1). The well pair is located adjacent to AOC 685. The shallow well, GDI010, was installed at 12.5 ft bgs in the upper sand layer of the Wando Formation. The deep well, GDI10D, was installed at 37 feet bgs at the base of the lower sand in the Wando. All wells were installed in accordance with Section 3 of this report.

Both wells were sampled during four events, and samples were analyzed for the standard suite of parameters (VOCs, SVOCs, metals, cyanide, pesticides, and PCBs) and TDS, chloride, sulfates, and organotins at DQO Level III. Appendix D contains the complete analytical data report for grid wells sampled as part of the Zone I investigation.

10.7.4 Nature and Extent of Groundwater Contamination

Volatile Organic Carbons in Groundwater

Two VOCs were detected in shallow groundwater. Acetone was detected in the third-round sample from well GDI010 at a concentration of 4,800 μg/L, which exceeded its tap-water RBC. 2-Butanone was detected in the second-round sample from GDI010 at a concentration of 3.0 μg/L. No other VOCs were detected in shallow or deep groundwater above the respective RBCs or MCLs.

Semivolatile Organic Carbons in Groundwater

No SVOCs were detected in shallow or deep groundwater at levels that exceeded the screening criteria.

Pesticides and PCBs in Groundwater

Four pesticides - dieldrin, 4,4'-DDE, 4,4'-DDT, and endrin aldehyde - were detected in the first-round shallow groundwater sample at concentrations that exceeded their respective RBCs or MCLs. No other pesticides or PCBs were detected in shallow or deep groundwater samples.

Other Organics in Groundwater

No dioxins, furans, or organotins were detected at levels above their respective screening criteria in shallow or deep groundwater samples.

Inorganics in Groundwater

Fifteen metals were detected in shallow groundwater samples. None exceeded the respective screening criteria. Three metals - lead, manganese, and thallium - were detected in deep groundwater samples above the screening criteria. Lead was detected in the first-round sample at a concentration of 26.2 μg/L. It was not detected in subsequent deep samples. Manganese was detected in the third round at a concentration of 690 μg/L. Thallium was detected in samples from the second (8.6 μg/L) and fourth-rounds(3.1 μg/L).

10.7.5 Fate and Transport Assessment

AOC 685, the former smoke drum site, was in operation from 1941 until 1953. The area was reportedly used to burn documents and other unknown materials. Currently, this area is a grassy field with no visible evidence of the former smoke drum activities. Products of incomplete combustion are the materials of concern. Environmental media sampled as part of this investigation were surface and subsurface soil. Potential constituent migration pathways evaluated include soil-to-groundwater and emission of volatiles from surface soil-to-air.

10.7.5.1 Soil-to-Groundwater Cross-Media Transport

Tables 10.7.5 and 10.7.6 compare maximum detected organic and inorganic constituent concentrations, respectively, in surface and subsurface soils to risk-based soil screening levels considered protective of groundwater. Maximum concentrations in soil are compared to leachability-based generic SSLs. The generic SSLs are used to provide a conservative screen leachate entering the aquifer is assumed to be diluted by a ratio of 10:1, with no attenuation of

Table 10.7.5
Organic Chemicals Detected in Surface Soil, Subsurface Soil, Sediment, and Shallow Groundwater
Comparison to Cross-Media SSLs, Tap-Water RBCs, and Saltwater Surface Water Chronic Screening Levels
AOC 685
Charleston Naval Complex
Charleston, South Carolina

Parameter	Maximum Concentration Surface Soil	Subsurface Soil	Sediment	Shallow GW	Screening Concentration Soil to GW SSL	Soil to Air SSL	Tap Water RBC	Saltwater Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Volatilization Potential	Groundwater Migration Concern	Surface Water Migration Concern
Volatile Organic Compounds														
Acetone	36	NA	NA	NA	8000	1.0E+08	3700	NA	μG/KG	μG/L	NO	NO	NO	NO
Toluene	6	NA	NA	NA	6000	650000	750	37	μG/KG	μG/L	NO	NO	NO	NO
Trichlorotrifluoroethane (Freon 113)	15	NA	NA	NA	NA	2400000	59000	NA	μG/KG	μG/L	NO	NO	NO	NO
Semivolatile Organic Compounds														
Acenaphthene	160	ND	NA	NA	290000	NA	2200	9.7	μG/KG	μG/L	NO	NO	NO	NO
Anthracene	200	ND	NA	NA	5900000	NA	11000	NA	μG/KG	μG/L	NO	NO	NO	NO
Benzo(g,h,i)perylene	1300	33	NA	NA	1.2E+08 a	NA	1500	NA	μG/KG	μG/L	NO	NO	NO	NO
Benzo(a)pyrene Equivalents	3746	104	NA	NA	1600 a	NA	0.0092	NA	μG/KG	μG/L	YES	NO	NO	NO
Benzo(a)anthracene c	2000	51	NA	NA	800	NA	0.092	NA	μG/KG	μG/L	YES	NO	NO	NO
Benzo(a)pyrene c	2700	88	NA	NA	4000	NA	0.0092	NA	μG/KG	μG/L	NO	NO	NO	NO
Benzo(b)fluoranthene c	3400	150	NA	NA	2500	NA	0.092	NA	μG/KG	μG/L	YES	NO	NO	NO
Benzo(k)fluoranthene c	1400	48	NA	NA	25000	NA	0.92	NA	μG/KG	μG/L	NO	NO	NO	NO
Chrysene c	2200	100	NA	NA	80000	NA	9.2	NA	μG/KG	μG/L	NO	NO	NO	NO
Dibenz(a,h)anthracene c	340	ND	NA	NA	800	NA	0.0092	NA	μG/KG	μG/L	NO	NO	NO	NO
Indeno(1,2,3-cd)pyrene c	1500	ND	NA	NA	7000	NA	0.092	NA	μG/KG	μG/L	NO	NO	NO	NO
Butylbenzylphthalate	61	ND	NA	NA	930000	930000	7300	29.4	μG/KG	μG/L	NO	NO	NO	NO
Dibenzofuran	49	ND	NA	NA	6800 a	120000	24	NA	μG/KG	μG/L	NO	NO	NO	NO
bis(2-Ethylhexyl)phthalate (BEHP) c	930	150	NA	NA	1800000	31000000	4.8	NA	μG/KG	μG/L	NO	NO	NO	NO
Fluoranthene	2600	220	NA	NA	2100000	NA	1500	1.6	μG/KG	μG/L	NO	NO	NO	NO
Fluorene	80	ND	NA	NA	280000	NA	1500	NA	μG/KG	μG/L	NO	NO	NO	NO
2-Methylnaphthalene	34	ND	NA	NA	230000 a	NA	1500	23.5	μG/KG	μG/L	NO	NO	NO	NO
3-Methylphenol (m-cresol)	160	ND	NA	NA	6700 a	NA	1800	NA	μG/KG	μG/L	NO	NO	NO	NO
4-Methylphenol (p-cresol)	160	ND	NA	NA	670 a	NA	180	NA	μG/KG	μG/L	NO	NO	NO	NO
Naphthalene	100	ND	NA	NA	42000	NA	1500	23.5	μG/KG	μG/L	NO	NO	NO	NO
Pentachlorophenol c	45	ND	NA	NA	13	NA	0.56	7.9	μG/KG	μG/L	YES	NO	NO	NO
Phenanthrene	1000	33	NA	NA	660000 a	NA	1100	NA	μG/KG	μG/L	NO	NO	NO	NO
Pyrene	2800	320	NA	NA	2100000	NA	1100	NA	μG/KG	μG/L	NO	NO	NO	NO
Pesticides/PCBs														
Aldrin c	1.7	NA	NA	NA	230	3000	0.0039	0.13	μG/KG	μG/L	NO	NO	NO	NO
delta-BHC (delta-HCH) c	0.41	NA	NA	NA	1.8 a	NA	0.037	NA	μG/KG	μG/L	NO	NO	NO	NO
gamma-BHC (Lindane) c	1.4	NA	NA	NA	4.5	NA	0.052	0.016	μG/KG	μG/L	NO	NO	NO	NO
Chlordane c	54	NA	NA	NA	5000	20000	0.19	0.004	μG/KG	μG/L	NO	NO	NO	NO
4,4'-DDD c	36	NA	NA	NA	8000	NA	0.28	0.025	μG/KG	μG/L	NO	NO	NO	NO
4,4'-DDE c	220	NA	NA	NA	27000	NA	0.2	0.14	μG/KG	μG/L	NO	NO	NO	NO
4,4'-DDT c	53	NA	NA	NA	16000	1E+09	0.2	0.001	μG/KG	μG/L	NO	NO	NO	NO
Dieldrin c	1.3	NA	NA	NA	2	1000	0.0042	0.0019	μG/KG	μG/L	NO	NO	NO	NO

Table 10.7.5
Organic Chemicals Detected in Surface Soil, Subsurface Soil, Sediment, and Shallow Groundwater
Comparison to Cross-Media SSLs, Tap-Water RBCs, and Saltwater Surface Water Chronic Screening Levels
AOC 685
Charleston Naval Complex
Charleston, South Carolina

Parameter	Maximum Concentration Surface Soil	Subsurface Soil	Sediment	Shallow GW	Screening Concentration Soil to GW SSL	Soil to Air SSL	Tap Water RBC	Saltwater Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Volatilization Potential	Groundwater Migration Concern	Surface Water Migration Concern
Endosulfan I	8.3	NA	NA	NA	9000 b	NA	220	0.0087	µG/KG	µG/L	NO	NO	NO	NO
Endosulfan sulfate	0.36	NA	NA	NA	4600 a	NA	220	NA	µG/KG	µG/L	NO	NO	NO	NO
Endrin	1.2	NA	NA	NA	500	NA	11	0.0023	µG/KG	µG/L	NO	NO	NO	NO
Endrin aldehyde	8.9	NA	NA	NA	340 a	NA	11	NA	µG/KG	µG/L	NO	NO	NO	NO
Heptachlor epoxide c	49	NA	NA	NA	330	5000	0.0012	0.0036	µG/KG	µG/L	NO	NO	NO	NO
Methoxychlor	5	NA	NA	NA	80000	NA	180	0.03	µG/KG	µG/L	NO	NO	NO	NO
Herbicides														
2,4-D	28	NA	NA	NA	370 a	7000000	61	NA	µG/KG	µG/L	NO	NO	NO	NO
2,4,5-T	8.1	NA	NA	NA	990 a	NA	370	NA	µG/KG	µG/L	NO	NO	NO	NO
2,4,5-TP (Silvex)	2.1	NA	NA	NA	5600 a	NA	290	NA	µG/KG	µG/L	NO	NO	NO	NO
TPH-GRO														
Gasoline	4800	NA	NA	NA	NA	NA	NA	NA	µG/KG	µG/L	NO	NO	NO	NO
Dioxin Compounds														
2,3,7,8-TCDD equivalents (TEQs) c	0.54	NA	NA	NA	1600 a	NA	0.45	10	NG/KG	PG/L	NO	NO	NO	NO
1234678-HpCDD c	20.4	NA	NA	NA	108000 a	NA	45	NA	NG/KG	PG/L	NO	NO	NO	NO
OCDD c	180	NA	NA	NA	1080000 a	NA	450	NA	NG/KG	PG/L	NO	NO	NO	NO
123678-HxCDF c	0.958	NA	NA	NA	216000 a	NA	4.5	NA	NG/KG	PG/L	NO	NO	NO	NO
1234678-HpCDF c	4.75	NA	NA	NA	54000 a	NA	45	NA	NG/KG	PG/L	NO	NO	NO	NO
OCDF c	7.74	NA	NA	NA	540000 a	NA	450	NA	NG/KG	PG/L	NO	NO	NO	NO

Notes:
Sources of screening concentrations appear in Table 5.5
Explanations of fate and transport screening procedures appear in Section 6.2.
Frequency and range of detections, average detected concentrations, and number of screening concentration exceedances appear in Table 10.7.2 and 10.7.4.

a - Calculated soil to groundwater SSL value (See Table 6.2)
b - Based on surrogate compound; see Table 5.5
c - Carcinogenic
GW - Groundwater

NA - Not applicable/not available
ND - Not detected
RBC - Risk-based concentration
SSL - Soil screening level

NG/KG - Nanograms per kilogram
µG/KG - Micrograms per kilogram
PG/L - Picograms per liter
µG/L - Micrograms per liter

Table 10.7.6
Inorganic Chemicals Detected in Surface Soil, Subsurface Soil, Sediment, and Shallow Groundwater
Comparison to Cross-Media SSLs, Tap-Water RBCs, Saltwater Surface Water Chronic Screening Levels, and Background Reference Values
AOC 685
Charleston Naval Complex
Charleston, South Carolina

Parameter	Maximum Concentration Surface Soil	Subsurface Soil	Sediment	Shallow GW	Screening Concentration Soil to GW SSL	Soil Background	Soil to Air SSL	Tap Water RBC	Shallow GW Background	Saltwater Surf. Wtr Chronic	Soil Units	Water Units	Leaching Potential	Fugitive Particulate Inhalation Concern	Ground-water Migration Concern	Surface Water Migration Concern
Inorganic Chemicals																
Aluminum (Al)	29900	40300	NA	NA	560000 a	27400	NA	37000	1440	NA	MG/KG	µG/L	NO	NO	NO	NO
Antimony (Sb)	21.4	ND	NA	NA	2.7	ND	NA	15	NA	NA	MG/KG	µG/L	YES	NO	NO	NO
Arsenic (As) c	30.3	30.6	NA	NA	15	21.6	750	0.045	23	36	MG/KG	µG/L	YES	NO	NO	NO
Barium (Ba)	54.4	57.6	NA	NA	820	54.2	690000	2600	110	NA	MG/KG	µG/L	NO	NO	NO	NO
Beryllium (Be)	1.4	1.7	NA	NA	32	0.95	1300	73	1.1	NA	MG/KG	µG/L	NO	NO	NO	NO
Cadmium (Cd)	0.97	0.6	NA	NA	4	0.61	1800	18	NA	9.3	MG/KG	µG/L	NO	NO	NO	NO
Chromium (Cr) (total)	83.5	85.7	NA	NA	19	51.3	270	180	14.3	50	MG/KG	µG/L	YES	NO	NO	NO
Cobalt (Co)	7.4	10.1	NA	NA	990 a	5.8	NA	2200	2.2	NA	MG/KG	µG/L	NO	NO	NO	NO
Copper (Cu)	494	45.9	NA	NA	5600 a	240	NA	1500	4.4	2.9	MG/KG	µG/L	NO	NO	NO	NO
Lead (Pb)	1110	35.4	NA	NA	400	203	400	15	4.4	8.5	MG/KG	µG/L	YES	YES	NO	NO
Manganese (Mn)	1920	3460	NA	NA	480 a	419	NA	730	5430	NA	MG/KG	µG/L	YES	NO	NO	NO
Mercury (Hg)	0.21	0.27	NA	NA	1	0.47	10	11	NA	0.025	MG/KG	µG/L	NO	NO	NO	NO
Nickel (Ni)	54.9	30.8	NA	NA	65	23.9	13000	730	13.3	8.3	MG/KG	µG/L	NO	NO	NO	NO
Selenium (Se)	2.1	0.68	NA	NA	2.6	1.77	NA	180	ND	71	MG/KG	µG/L	NO	NO	NO	NO
Thallium (Tl)	0.71	ND	NA	NA	0.36	ND	NA	2.6	2	21.3	MG/KG	µG/L	YES	NO	NO	NO
Tin (Sn)	42	5.1	NA	NA	5500 a	7.5	NA	22000	NA	NA	MG/KG	µG/L	NO	NO	NO	NO
Vanadium (V)	74.5	90.9	NA	NA	3000	113	NA	260	14	NA	MG/KG	µG/L	NO	NO	NO	NO
Zinc (Zn)	876	118	NA	NA	6200	206	NA	11000	24.4	86	MG/KG	µG/L	NO	NO	NO	NO

Notes:
Sources of screening concentrations appear in Table 5.6
Explanations of fate and transport screening procedures appear in Section 6.2.
Frequency and range of detections, average detected concentrations, and number of screening concentration exceedances appear in Tables 10.7.3 and 10.7.4.

Background values for soil are shown for comparison purposes only.
Maximum groundwater concentrations are screened against the greater of tap-water RBCs or corresponding background values to determine groundwater migration concern.

a - Calculated soil to groundwater SSL value (See Table 6.2)
c - Carcinogenic
GW - Groundwater

NA - Not available/Not applicable
ND - Not detected
RBC - Risk-based concentration

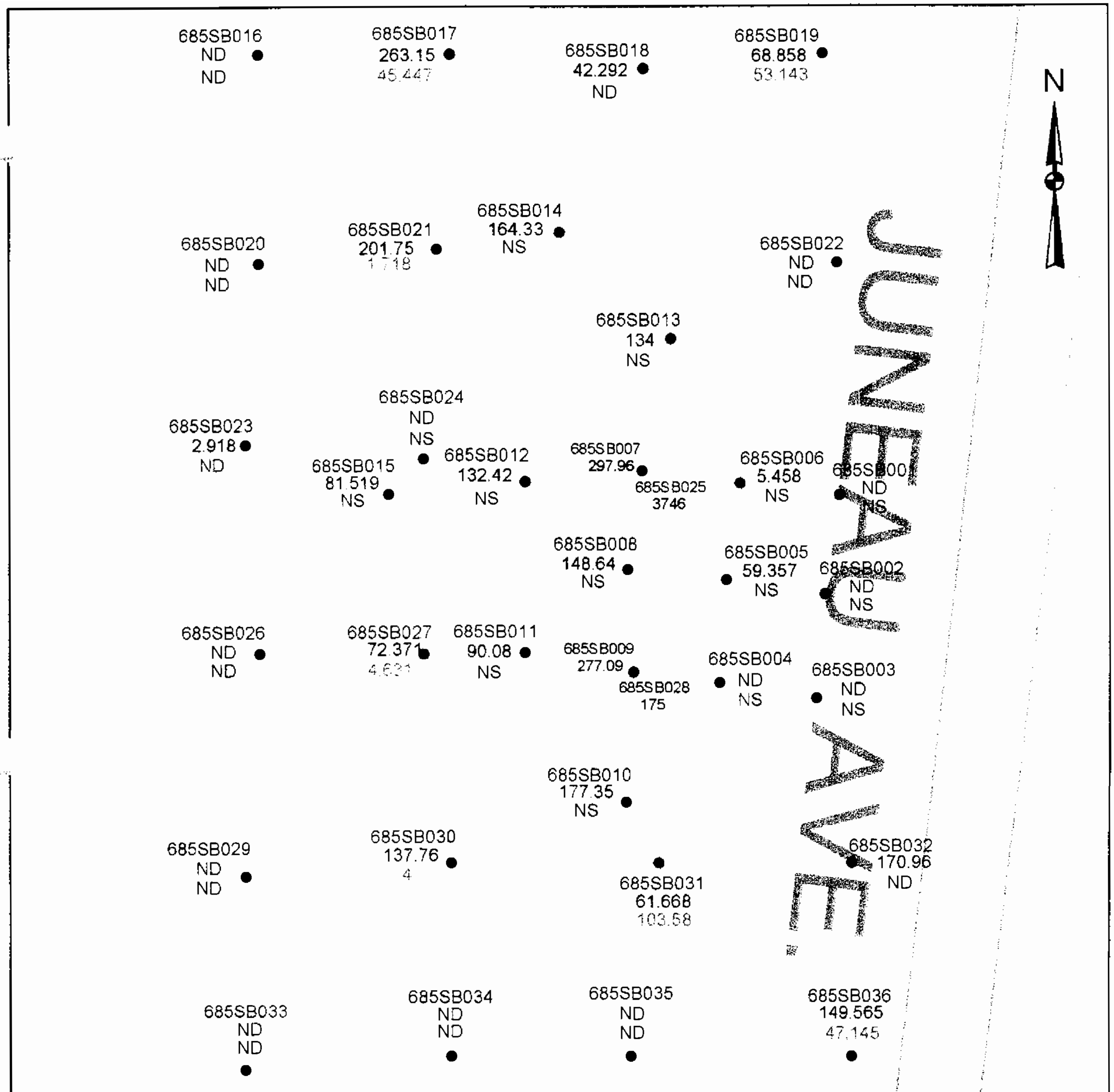
SSL - Soil screening level
MG/KG - Milligrams per kilogram
µG/L - Micrograms per liter

constituents in soil (DAF = 10). Soil background values for inorganics in Zone I were determined, but at the request of SCDHEC were not considered during initial comparisons of maximum soil concentrations with SSLs.

Four organic constituents - benzo(a)pyrene equivalents, benzo(a)anthracene, benzo(b)flouranthene, and pentachlorophenol - were present in surface soil at concentrations above their SSLs. All were below their SSLs in subsurface soil; however, some subsurface locations were not sampled due to a high water table. BEQs were detected in 23 of 36 surface soil samples. There were no discernable spatial trends in BEQ concentrations, as shown in Figure 10.7.2. Benzo(a)anthracene was detected in 22 of 36 surface soil samples, with only one SSL exceedance 685SB02501. Again, there were no remarkable spatial trends, as shown in Figure 10.7.3. Benzo(b)flouranthene detections were identical to those for benzo(a)anthracene. Figure 10.7.4 presents benzo(b)flouranthene concentrations detected at AOC 685. Pentachlorophenol was detected in only one of 36 surface soil samples; there was no subsurface sample collected from the detection location. Figure 10.7.5 presents the pentachlorophenol concentration detected at AOC 685.

The presence of these semivolatiles is entirely consistent with past site activities; they are routinely detected as residual components from incomplete combustion. The relatively widespread occurrence of all but pentachlorophenol indicates a significant mass, but concentrations above SSLs are limited to the general area near 685SB025. The limited detection of pentachlorophenol suggests a small residual mass. All organic exceedances were detected immediately adjacent to groundwater, and therefore the pathway is considered valid.

Six inorganic parameters - antimony, arsenic, chromium, lead, manganese, and thallium - were detected at concentrations above their respective SSLs. Antimony was detected in nine of 36 surface soil samples, with exceedances at 685SB00201 and 685SB00901. Figure 10.7.6 presents antimony concentrations detected at AOC 685. Arsenic was widely detected, with six



LEGEND

■	MONITORING WELL LOCATION
●	ZONE I SOIL BORING LOCATION
12.30	ZONE I SURFACE SOIL CONC. (UG/KG)
12.30	ZONE I SUBSURFACE SOIL CONC. (UG/KG)
12.30	MAXIMUM QUARTERLY GW CONC. (UG/L)
NS	NO SAMPLE TAKEN
ND	NON DETECT

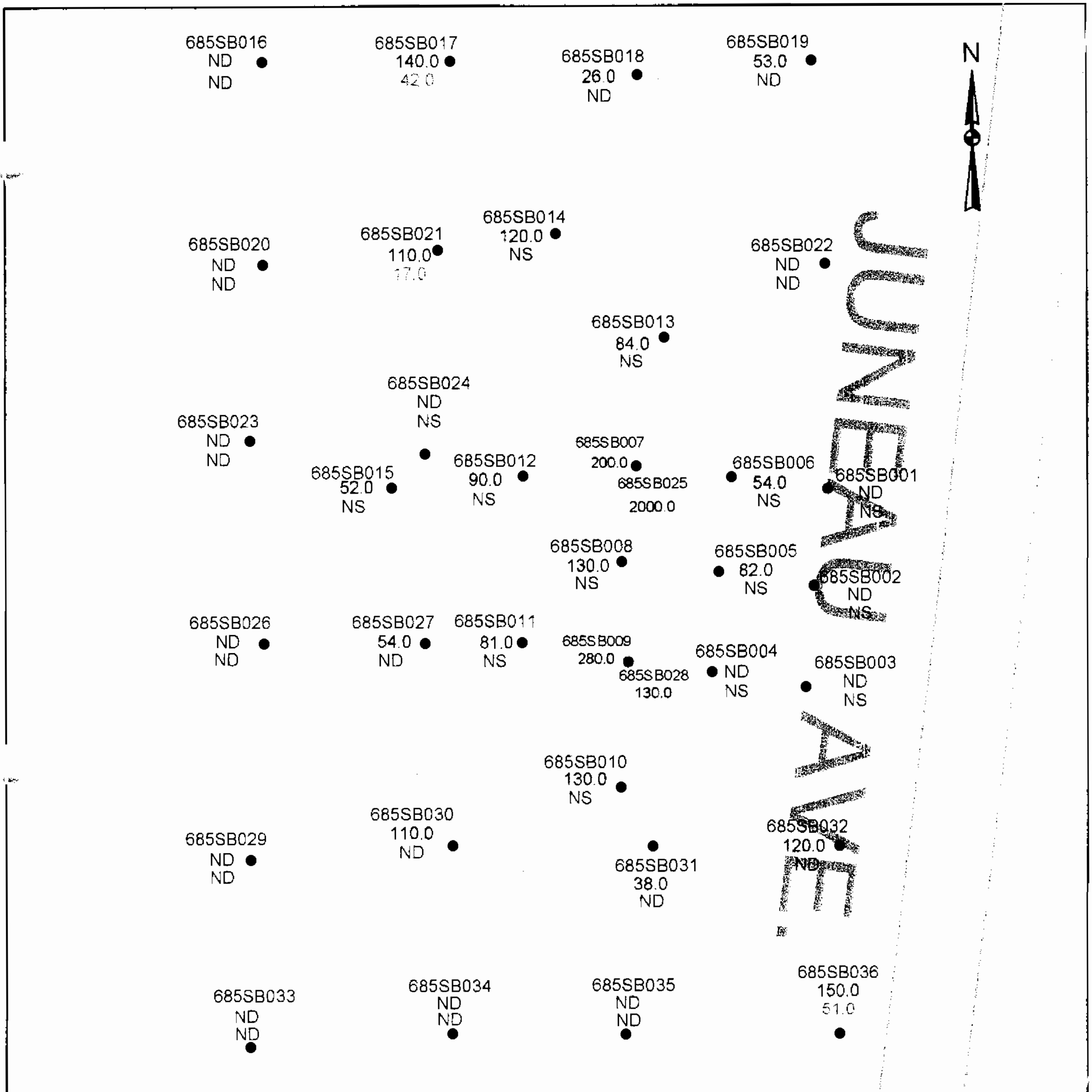
SCALE

20 0 20 40 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.7.2
ZONE I
AOC 685
BEQs
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=2 UG/L RBC=87 UG/KG SSL=1600 UG/KG



LEGEND

- ■ MONITORING WELL LOCATION
- ● ZONE I SOIL BORING LOCATION
- 12.30 ZONE I SURFACE SOIL CONC. (UG/KG)
- 12.30 ZONE I SUBSURFACE SOIL CONC. (UG/KG)
- *12.30* MAXIMUM QUARTERLY GW CONC. (UG/L)
- NS NO SAMPLE TAKEN
- ND NON DETECT

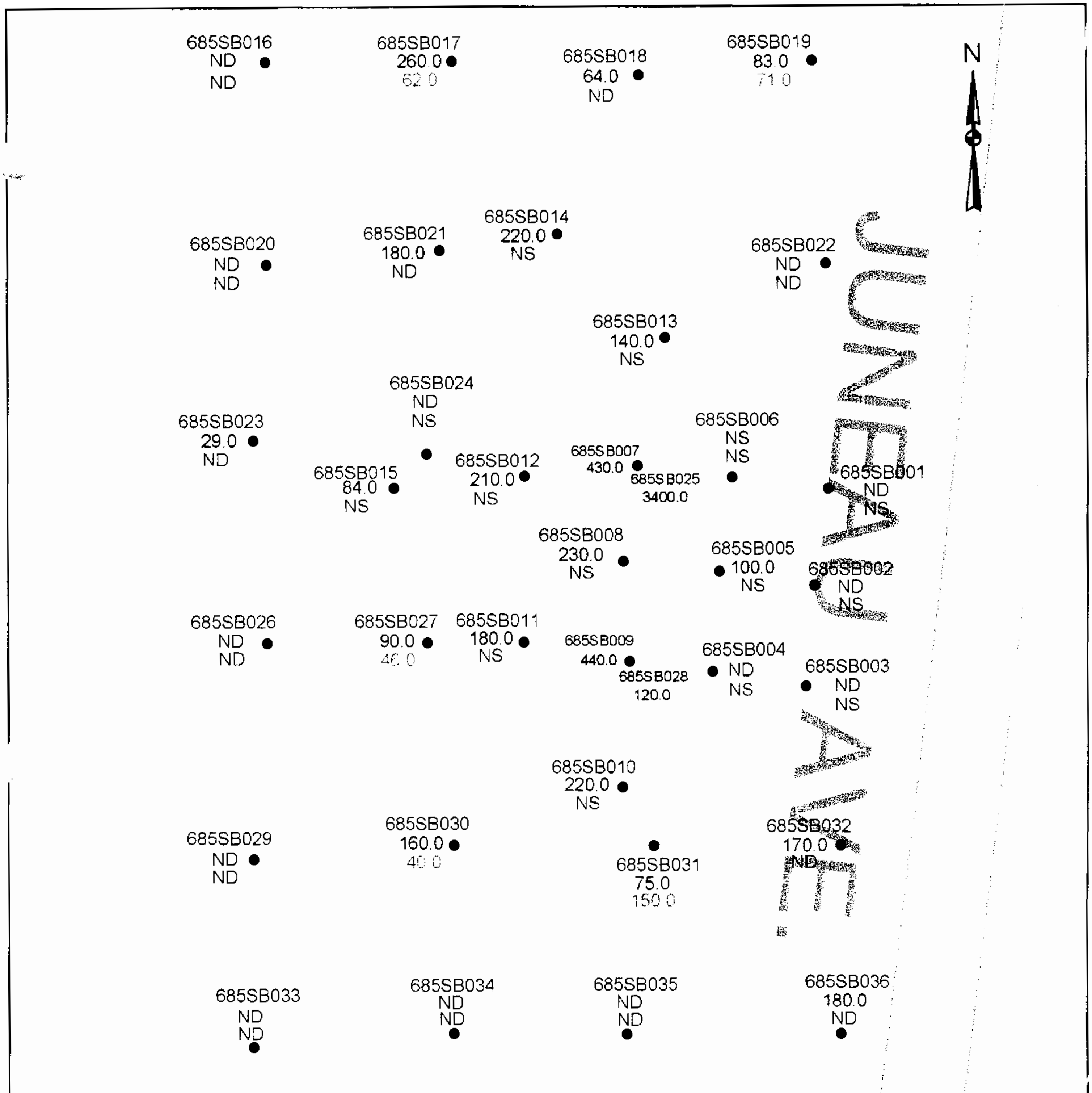
SCALE

20 0 20 40 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.7.3
ZONE I
AOC 685
BENZO(A)ANTHRACENE
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=NA RBC=870 UG/KG SSL=800 UG/KG



LEGEND

- ■ MONITORING WELL LOCATION
- ● ZONE I SOIL BORING LOCATION
- 12.30 ZONE I SURFACE SOIL CONC. (UG/KG)
- 12.30 ZONE I SUBSURFACE SOIL CONC. (UG/KG)
- *12.30* MAXIMUM QUARTERLY GW CONC. (UG/L)
- NS NO SAMPLE TAKEN
- ND NON DETECT

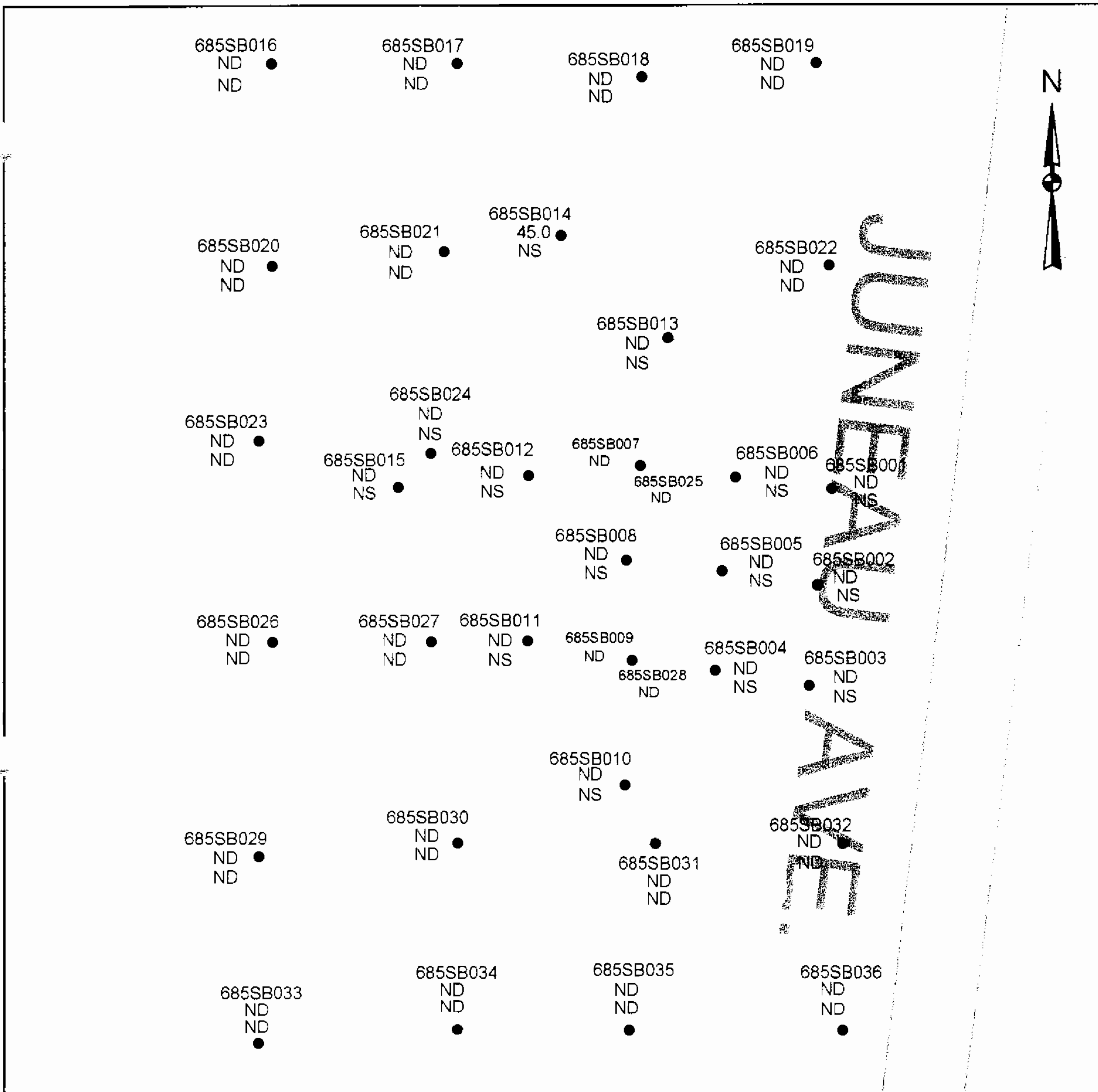
SCALE

20 0 20 40 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.7.4
ZONE I
AOC 685
BENZO(B)FLUORANTHENE
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=NA RBC=870 UG/KG SSL=2500 UG/KG



LEGEND

■	MONITORING WELL LOCATION
●	ZONE I SOIL BORING LOCATION
12.30	ZONE I SURFACE SOIL CONC. (UG/KG)
12.30	ZONE I SUBSURFACE SOIL CONC. (UG/KG)
12.30	MAXIMUM QUARTERLY GW CONC. (UG/L)
NS	NO SAMPLE TAKEN
ND	NON DETECT

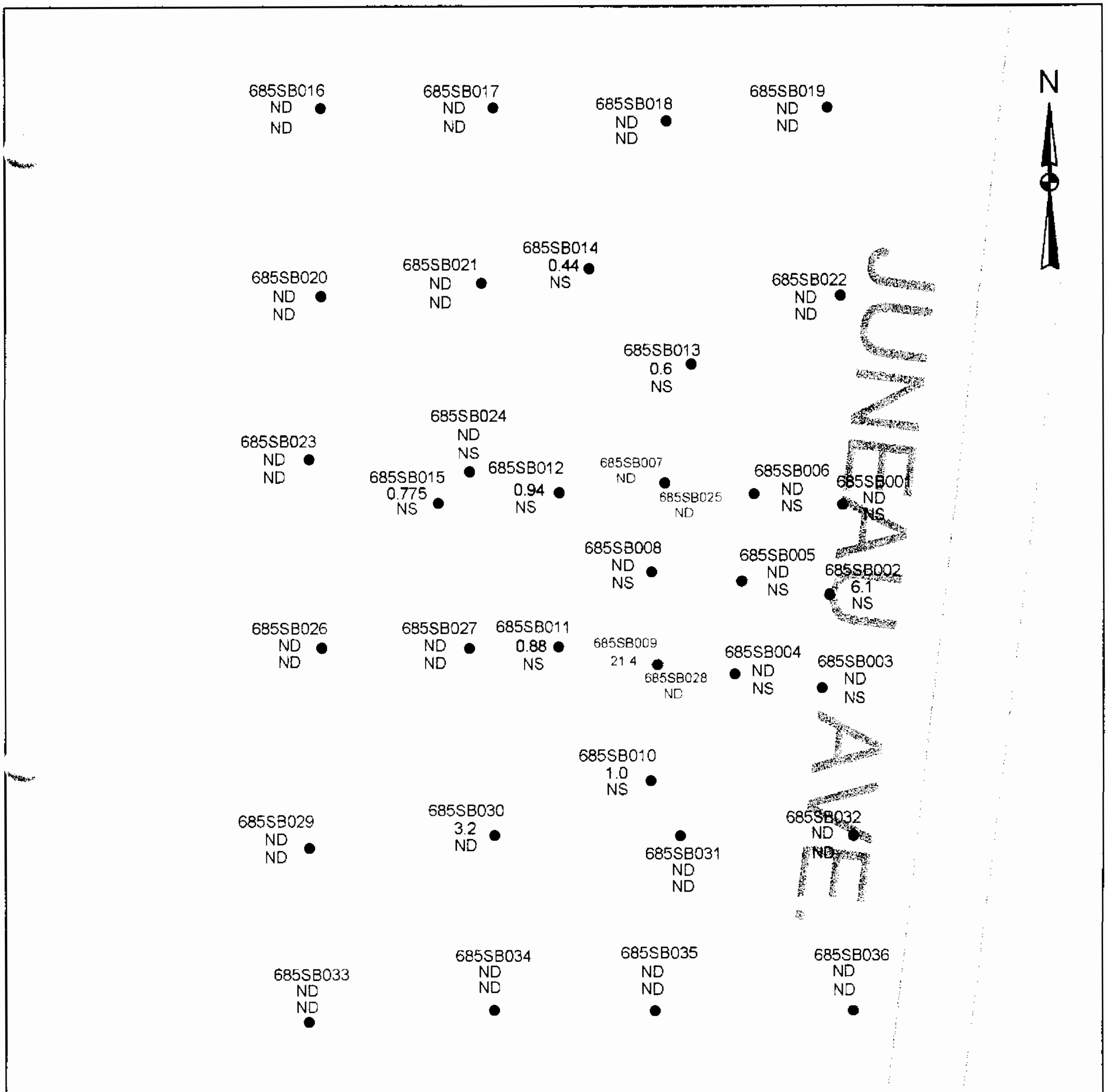
SCALE

20 0 20 40 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.7.5
ZONE I
AOC 685
PENTACHLOROPHENOL
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=1 UG/L RBC=5300 UG/KG SSL=13 UG/KG



LEGEND

■	MONITORING WELL LOCATION
●	ZONE I SOIL BORING LOCATION
12.30	ZONE I SURFACE SOIL CONC. (MG/KG)
12.30	ZONE I SUBSURFACE SOIL CONC. (MG/KG)
12.30	MAXIMUM QUARTERLY GW CONC. (UG/L)
NS	NO SAMPLE TAKEN
ND	NON DETECT

SCALE

20 0 20 40 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.7.6
ZONE I
AOC 685
ANTIMONY
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=6 UG/L RBC=3.1 MG/KG SSL=2.7 MG/KG

surface soil samples exceeding the SSL but only one above background. Most of these exceedances were repeated in the subsurface, with 13 samples exceeding background and 17 exceeding the SSL. Figure 10.7.7 presents arsenic concentrations detected.

Chromium was also widely detected, with 35 samples exceeding the SSL and 25 exceeding background in the surface soil. Most of these were repeated in the subsurface, with 17 exceeding the SSL and 13 above background. Figure 10.7.8 presents chromium concentrations detected. Lead was detected in all soil samples. In the surface, four exceeded background and the SSL; in the subsurface, none exceeded the SSL but 17 exceeded background. Lead concentrations are shown on Figure 10.7.9. Manganese was widely detected, with 16 samples above background and 14 exceeding the SSL in surface soil. In the subsurface, 16 samples were above background, and five exceeded the SSL. Figure 10.7.10 presents manganese concentrations detected. Thallium was detected in only one of 36 surface soil samples, at a concentration above both background and the SSL. The subsurface at this location was not sampled. Figure 10.7.11 presents thallium concentrations detected at AOC 685.

The detected inorganics can be "grouped" relative to their distribution at the site. Antimony and thallium have been detected sporadically in Zone I soil, and their presence does not necessarily indicate site contamination. The limited detections at AOC 685 clearly suggest a small mass, but the vertical distribution of data indicates that the soil-to-groundwater pathway is valid. Arsenic and chromium are widespread in Zone I soil; the concentrations at this AOC are notably higher than background. Past site activities would not be expected to produce arsenic and chromium as residual contaminants. Their widespread presence and relatively high concentrations indicate the pathway is valid for them.

Lead is not a common constituent in zone-wide soil. The lead at AOC 685 could be a residual from burning of materials with leaded fuel. There is a significant mass in soil above background with higher concentrations in surface soil, characteristics which suggest a mechanism such as burning which produces even distribution. The presence of lead in the subsurface indicates the soil-to-groundwater pathway is valid, but the absence of SSL exceedances may limit the significance.

Manganese is a common parameter in Zone I soil. The spatial distribution of manganese at AOC 685 is notable in that the highest surface concentrations are along a north-south trend (consistent with the boundary of the site along the Cooper River) on the far west extent of soil borings. The trend in subsurface soil is similar, except that the highest concentrations are located immediately east of those in surface soil. This distribution may be related to a) past site activities (unlikely based on site history; b) placement of fill along the shore of the Cooper River; and/or c) a diagenetic geochemical effect associated with tidal fluctuations along the Cooper River interacting with near onshore lithologies. The presence of manganese in subsurface soil at levels exceeding the SSL and background indicates, however, that the soil-to-groundwater pathway has merit.

10.7.5.2 Soil-to-Air Cross-Media Transport

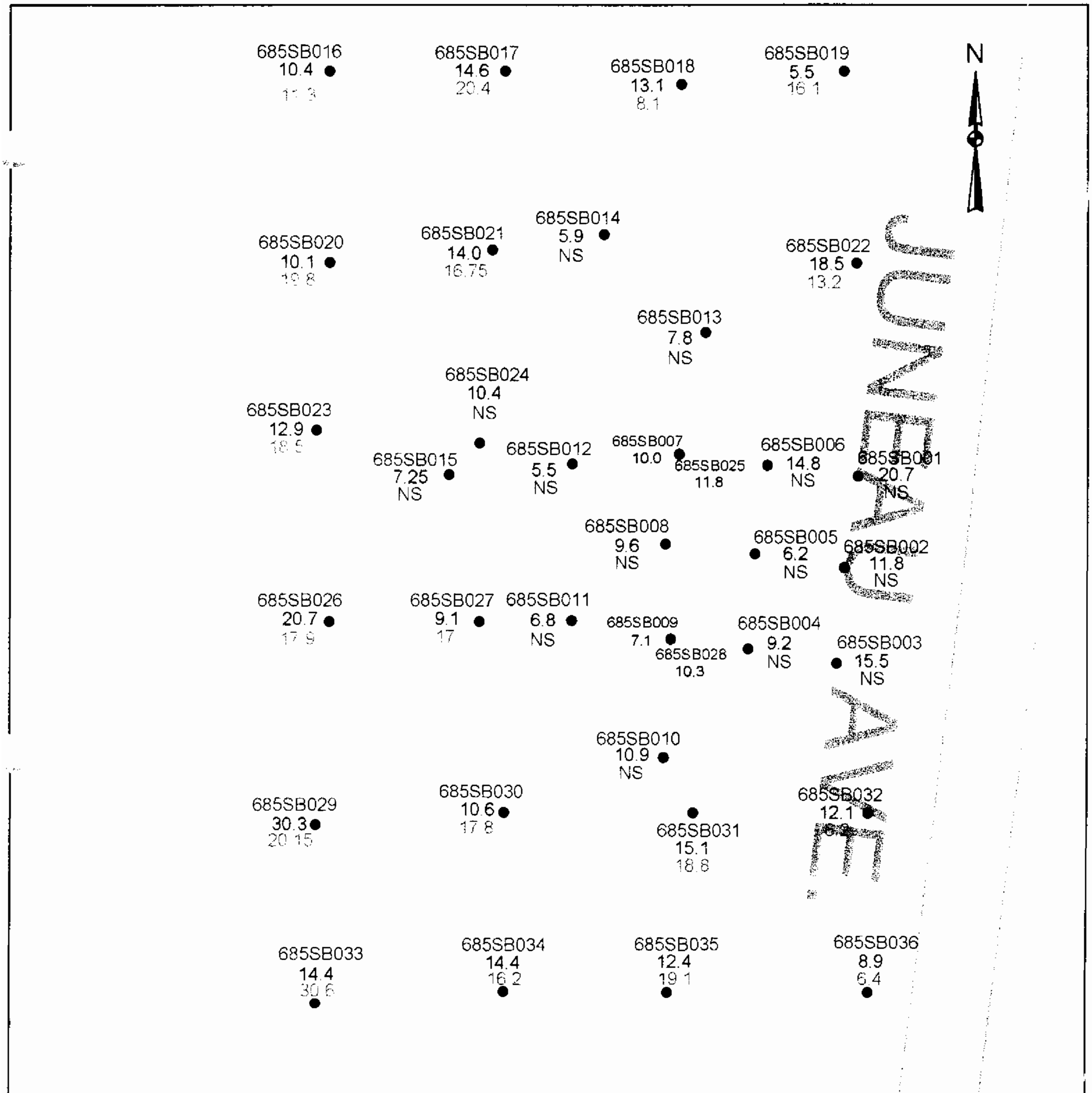
No VOCs were detected in surface soil above appropriate volatilization SSLs at this site, so this pathway is considered invalid.

10.7.5.3 Fate and Transport Summary

Soil-to-Groundwater Pathway

Four organic constituents – benzo(a)pyrene equivalents, benzo(a)anthracene, benzo(b)flouranthene, and pentachlorophenol - are present at levels exceeding their respective SSLs.

- All organics but pentachlorophenol were widely distributed, but concentrations exceeded SSLs only in the area near 685SB02501. Subsurface soil was not sampled at this location.



LEGEND

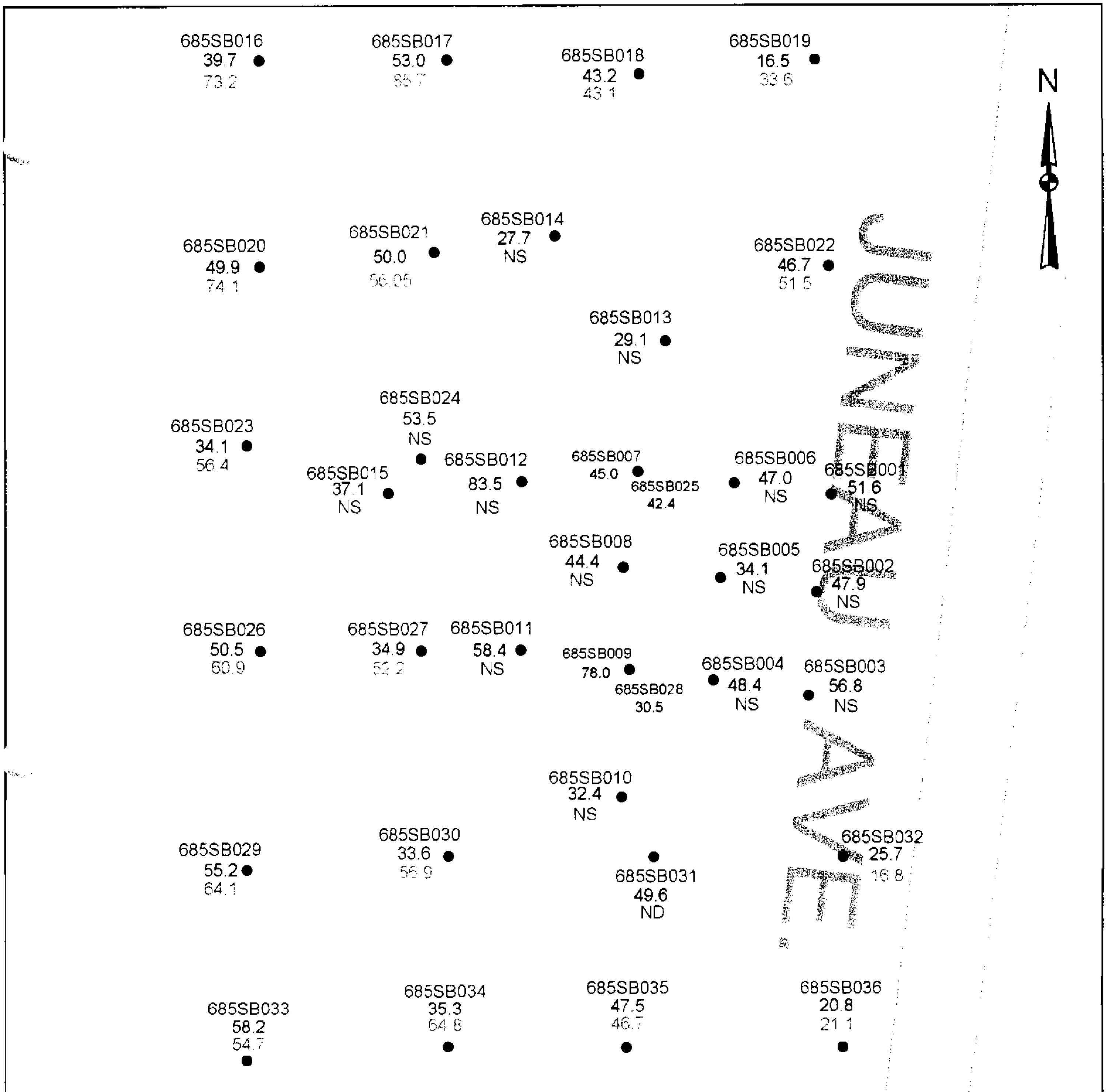
■ MONITORING WELL LOCATION
● ZONE I SOIL BORING LOCATION
12.30 ZONE I SURFACE SOIL CONC. (MG/KG)
12.30 ZONE I SUBSURFACE SOIL CONC. (MG/KG)
12.30 MAXIMUM QUARTERLY GW CONC. (UG/L)
NS NO SAMPLE TAKEN
ND NON DETECT

SCALE
20 0 20 40 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.7.7
ZONE I
AOC 685
ARSENIC
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=50 UG/L RBC=.43 MG/KG SSL=15 MG/KG



LEGEND

■	MONITORING WELL LOCATION
●	ZONE I SOIL BORING LOCATION
12.30	ZONE I SURFACE SOIL CONC. (MG/KG)
12.30	ZONE I SUBSURFACE SOIL CONC. (MG/KG)
12.30	MAXIMUM QUARTERLY GW CONC. (UG/L)
NS	NO SAMPLE TAKEN
ND	NON DETECT

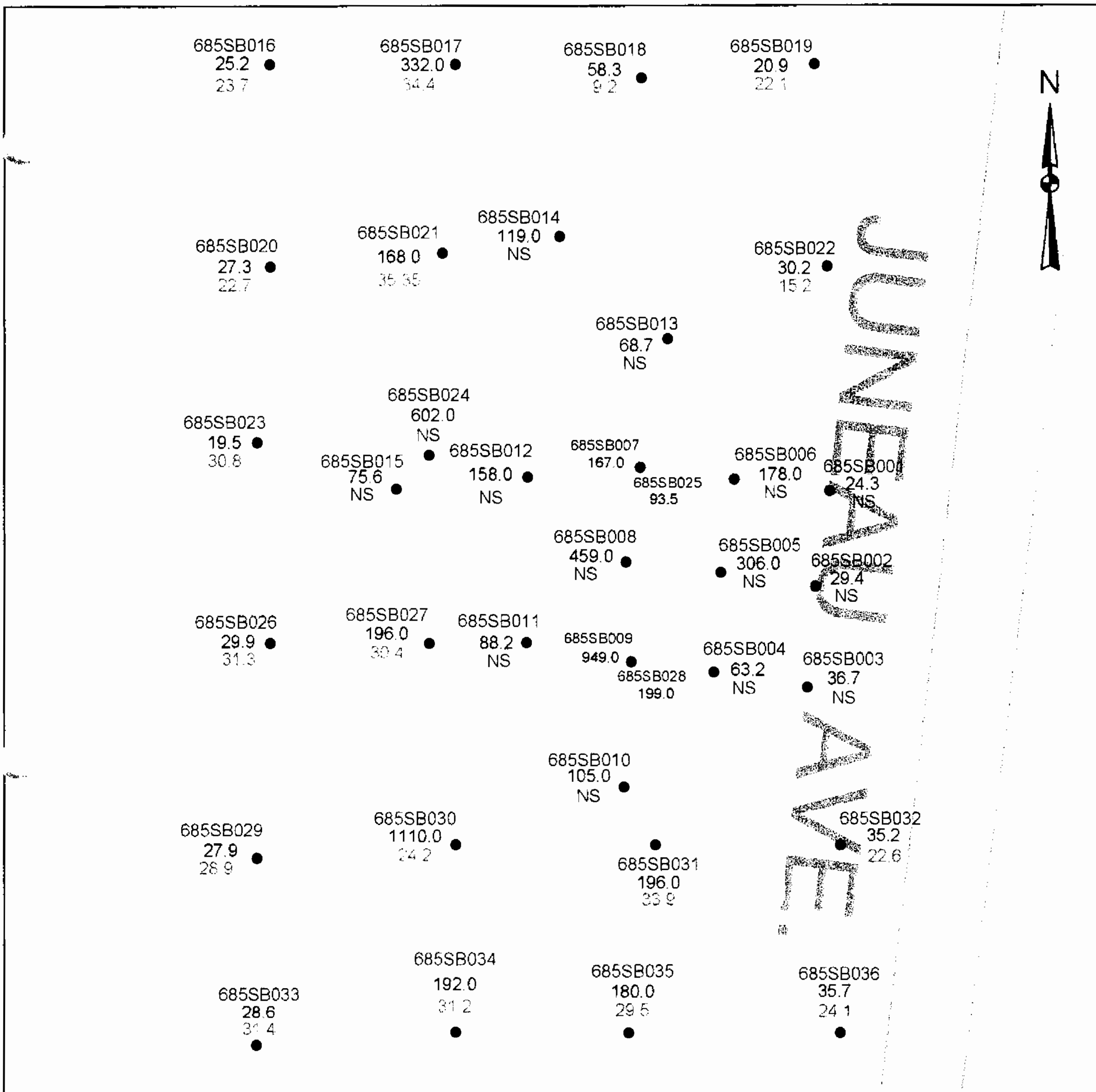
SCALE

20 0 20 40 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.7.8
ZONE I
AOC 685
CHROMIUM
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=100 UG/L RBC=39 MG/KG SSL=19 MG/KG



LEGEND

■	MONITORING WELL LOCATION
●	ZONE I SOIL BORING LOCATION
12.30	ZONE I SURFACE SOIL CONC. (MG/KG)
12.30	ZONE I SUBSURFACE SOIL CONC. (MG/KG)
12.30	MAXIMUM QUARTERLY GW CONC. (UG/L)
NS	NO SAMPLE TAKEN
ND	NON DETECT

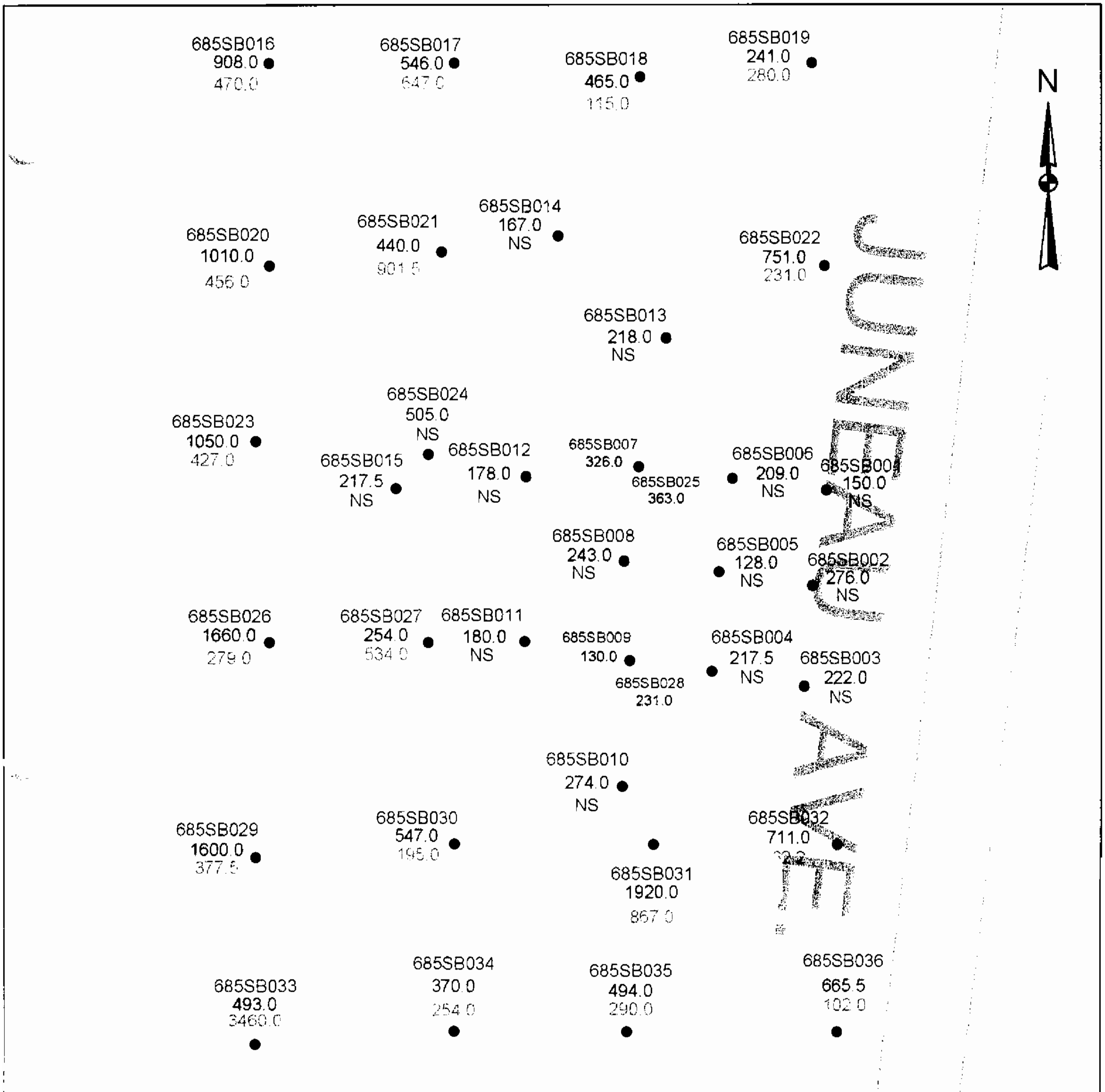
SCALE

20 0 20 40 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.7.9
ZONE I
AOC 685
LEAD
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=15 UG/L RBC=400 MG/KG SSL=400 MG/KG



LEGEND

■	MONITORING WELL LOCATION
●	ZONE I SOIL BORING LOCATION
12.30	ZONE I SURFACE SOIL CONC. (MG/KG)
12.30	ZONE I SUBSURFACE SOIL CONC. (MG/KG)
12.30	MAXIMUM QUARTERLY GW CONC. (UG/L)
NS	NO SAMPLE TAKEN
ND	NON DETECT

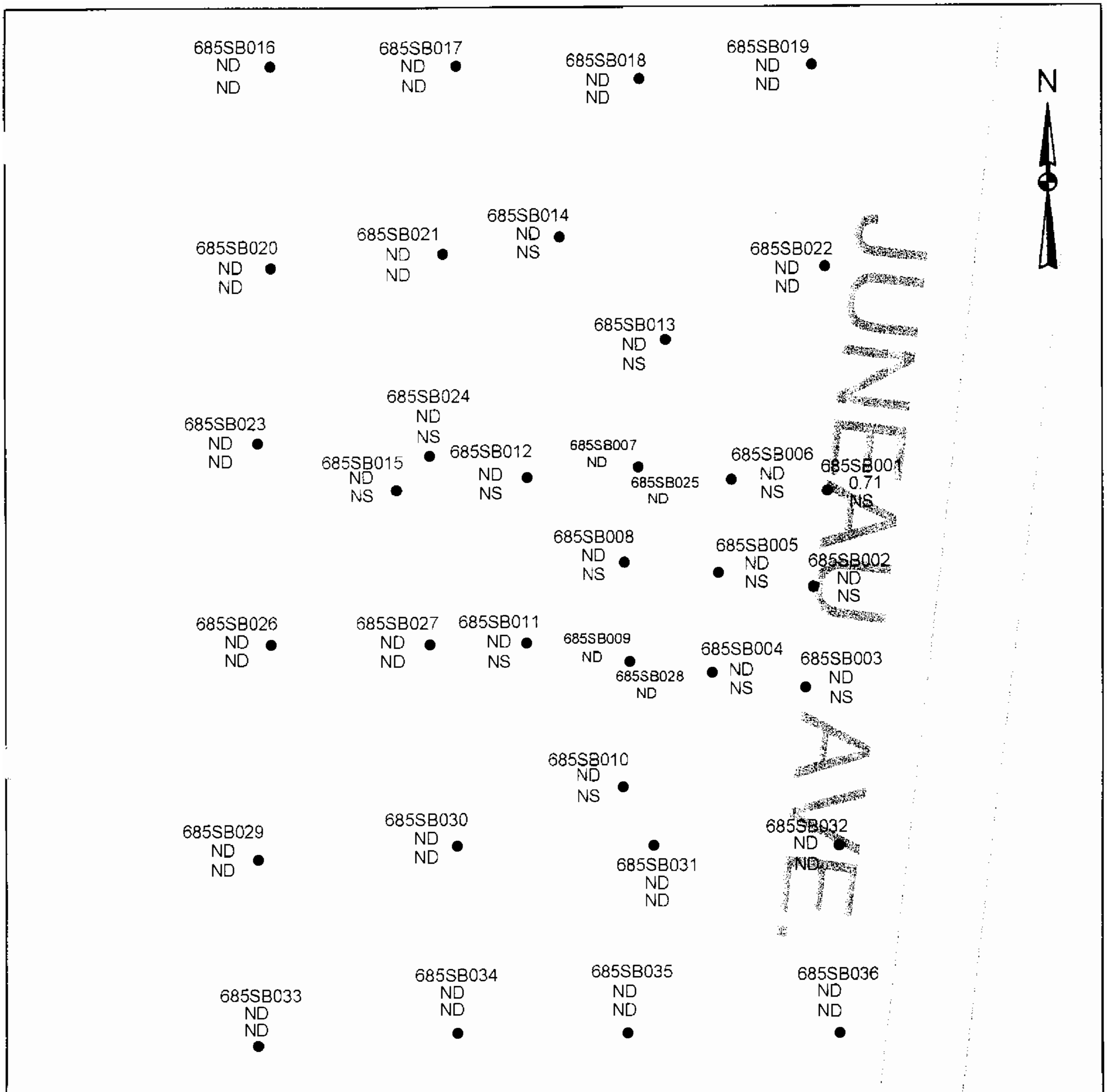
SCALE

20 0 20 40 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.7.10
ZONE I
AOC 685
MANGANESE
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=NA RBC=160 MG/KG SSL=480 MG/KG



LEGEND

■	MONITORING WELL LOCATION
●	ZONE I SOIL BORING LOCATION
12.30	ZONE I SURFACE SOIL CONC. (MG/KG)
12.30	ZONE I SUBSURFACE SOIL CONC. (MG/KG)
12.30	MAXIMUM QUARTERLY GW CONC. (UG/L)
NS	NO SAMPLE TAKEN
ND	NON DETECT

SCALE

20 0 20 40 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.7.11
ZONE I
AOC 685
THALLIUM
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=2 UG/L RBC=.55 MG/KG SSL=.36 MG/KG

- Pentachlorophenol was detected in only one surface sample (685SB014). Subsurface soil was not sampled at this location.

- The presence of these semivolatiles is entirely consistent with past site activities. There is limited residual mass above SSLs, and, due to a high water table, these exceedances are considered to be immediately above groundwater. Thus, the soil-to-groundwater pathway is valid for these constituents.

Six inorganic parameters - antimony, arsenic, chromium, lead, manganese, and thallium - are present at levels exceeding their respective SSLs.

- Antimony and thallium have been detected sporadically in Zone I soil, and do not necessarily indicate site contamination. Limited detections suggest a small mass, but the vertical distribution indicates that the pathway is valid.

- Arsenic and chromium are common constituents in Zone I soil, but the concentrations detected at this AOC tend to be higher than those normally encountered, a fact that is unexpected given the past site activities. Their widespread occurrence and relatively high concentrations indicate that the soil-to-groundwater pathway is valid for them.

- Although widely detected at this AOC, lead is not common in Zone I soil. It may be present as a result of leaded fuel use in past burning operations at this facility. There is a significant mass in soil, but the lack of lead above SSLs in subsurface soil diminishes the significance of the pathway.

- Manganese is a common constituent in Zone I soil. At this AOC, the trend of manganese is remarkable: the highest concentrations in surface soil are immediately to the west of the site and trend north-south consistent with the trend of the adjacent Cooper River. The highest concentrations in the subsurface are immediately east of those in the surface soil. These trends are likely due to the position of native and/or non-native lithologies on the site rather than site activities, but the presence of manganese in subsurface soil at levels above the SSL and background certainly indicate that the pathway has merit.

Soil-to-Air Pathway

No VOCs were detected above volatilization screening values, so the pathway is considered invalid for this AOC.

10.7.6 Human Health Risk Assessment

10.7.6.1 Site Background and Investigative Approach

The purpose of the investigation at AOC 685 was the assessment of soil and groundwater potentially affected by past site activities. AOC 685 is a former smoke drum site, reportedly used for the incineration of documents and other waste materials. Currently, this area is a grassy field with no visible evidence of the former smoke drum activities.

Soil was sampled in three rounds at AOC 685 from the locations shown on Figure 10.7.1. All nine first-round upper-interval samples were collected. No lower-interval soil samples were collected because the water table was encountered at less than 5 feet bgs; saturated samples were not submitted for analysis. First-round samples were submitted for analysis of organotins and the standard suite of parameters which includes VOCs, SVOCs, metals, cyanide, pesticides, and PCBs at DQO Level III. One first-round duplicate sample was submitted for Appendix IX parameters at DQO Level IV. Second-round sampling was performed following a comparison of first-round analytical results to the USEPA Region III RBCs. Six second-round samples were collected to delineate the nature and extent of SVOCs and metals. One second round sample was duplicated and submitted for Appendix IX parameters and TPH GRO/DRO at DQO Level IV. Third round sampling was also performed with 21 upper and 18 lower samples taken and analyzed for metals and SVOCs analyses. Three third sound samples were duplicated and submitted for metals and SVOC analysis.

No groundwater sampling was performed in.conjunction with the AOC 685 RFI.

10.7.6.2 COPC Identification

Soil

Based on the screening comparisons described in Section 7 of this RFI and presented in Table 10.7.7, the following COPCs were identified: benzo(a)pyrene equivalents, aluminum, antimony, arsenic, chromium, copper, lead, manganese, and thallium. Vanadium was identified as a COPC based on the results of Wilcoxon rank sum test analyses.

10.7.6.3 Exposure Assessment

Exposure Setting

AOC 685 is a former smoke drum site. No base operations are currently conducted at AOC 685. This area is slated to be maintained as an undeveloped open buffer area, according to current base reuse plans. Groundwater is not currently used the future as potable or process water, nor is such use anticipated in the future.

Potentially Exposed Populations

Potentially exposed populations are current and future site workers, hypothetical future site residents, and adolescent trespassers. Future site resident and worker exposure scenarios were addressed quantitatively in this risk assessment. The future site resident scenario was built on the premise that existing features would be removed and replaced with dwellings. The resident child scenario was considered to be conservatively representative of the adolescent trespasser.

Table 10.7.7
Chemicals Present in Site Samples
AOC 685 - Surface Soil
Charleston Naval Complex
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration Residential RBC	Background	Units	Number Exceeding RBC	Number Exceeding Background
Carcinogenic PAHs													
Benzo(a)pyrene Equivalents	*	23	36	2.92	3746	290	440	1800	87	NA	µG/KG	15	
Benzo(a)anthracene	*	22	36	26	2000	192	420	920	870	NA	µG/KG	1	
Benzo(a)pyrene	*	21	36	33	2700	235	420	920	87	NA	µG/KG	14	
Benzo(b)fluoranthene	*	22	36	29	3400	321	420	1100	870	NA	µG/KG	1	
Benzo(k)fluoranthene		20	36	26	1400	226	420	860	8700	NA	µG/KG		
Chrysene		23	36	18	2200	207	420	750	87000	NA	µG/KG		
Dibenz(a,h)anthracene	*	1	36	340	340	340	420	630	87	NA	µG/KG	1	
Indeno(1,2,3-cd)pyrene	*	8	36	32	1500	254	420	640	870	NA	µG/KG	1	
Inorganics													
Aluminum (Al)	*	36	36	8350	29900	17968	NA	NA	7800	27400	MG/KG	36	3
Antimony (Sb)	*	9	36	0.44	21.4	3.93	0.42	5.8	3.1	ND	MG/KG	3	
Arsenic (As)	*	36	36	5.5	30.3	11.9	NA	NA	0.43	21.6	MG/KG	36	1
Barium (Ba)		36	36	15.7	54.4	33.6	NA	NA	550	54.2	MG/KG		1
Beryllium (Be)		31	36	0.55	1.4	0.904	0.35	0.9	16	0.95	MG/KG		14
Cadmium (Cd)		11	36	0.07	0.97	0.384	0.03	0.62	7.8	0.61	MG/KG		4
Calcium (Ca)	N	36	36	21200	114000	48000	NA	NA	NA	NA	MG/KG		
Chromium (Cr)(total)	*	36	36	16.5	83.5	44.2	NA	NA	39	34.5	MG/KG	23	26
Cobalt (Co)		36	36	1.8	7.4	4.86	NA	NA	470	5.8	MG/KG		14
Copper (Cu)	*	36	36	13.4	494	121	NA	NA	310	240	MG/KG	4	6
Iron (Fe)	N	36	36	8320	41500	18303	NA	NA	NA	NA	MG/KG		
Lead (Pb)	*	36	36	19.5	1110	179	NA	NA	400	203	MG/KG	4	6
Magnesium (Mg)	N	36	36	2010	6690	4053	NA	NA	NA	NA	MG/KG		
Manganese (Mn)	*	36	36	128	1920	514	NA	NA	160	419	MG/KG	33	16
Mercury (Hg)		29	36	0.03	0.21	0.123	0.11	0.2	2.3	0.47	MG/KG		
Nickel (Ni)		36	36	6.5	54.9	21.3	NA	NA	160	23.9	MG/KG		10
Potassium (K)	N	36	36	719	3000	1562	NA	NA	NA	NA	MG/KG		
Selenium (Se)		11	36	0.58	2.1	1.00	0.33	1.1	39	1.49	MG/KG		1
Sodium (Na)	N	36	36	501	4140	1112	NA	NA	NA	NA	MG/KG		
Thallium (Tl)	*	1	36	0.71	0.71	0.71	0.33	1.2	0.55	ND	MG/KG	1	
Tin (Sn)		26	36	1.2	42	12.0	1.9	8.6	4700	7.5	MG/KG		12
Vanadium (V)		30	36	18.7	74.5	44.1	24.8	34.7	55	113	MG/KG	7	
Zinc (Zn)		36	36	30.1	876	202	NA	NA	2300	206	MG/KG		10

Table 10.7.7
Chemicals Present in Site Samples
AOC 685 - Surface Soil
Charleston Naval Complex
Charleston, South Carolina

Parameter	Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration Residential RBC	Background	Units	Number Exceeding RBC	Background
Pesticides												
4,4'-DDD	7	10	6.3	36	14.6	4.3	4.9	2700	NA	μG/KG		
4,4'-DDE	7	10	8.4	220	65.4	2	4.8	1900	NA	μG/KG		
4,4'-DDT	7	10	0.53	53	18.3	4.3	4.5	1900	NA	μG/KG		
Aldrin	1	10	1.7	1.7	1.7	0.58	1.4	38	NA	μG/KG		
Chlordane	1	10	54	54	54	4.8	5.6	1800	NA	μG/KG		
delta-BHC	1	10	0.41	0.41	0.41	1.2	1.4	350	NA	μG/KG		
Dieldrin	1	10	1.3	1.3	1.3	1.8	2.1	40	NA	μG/KG		
Endosulfan I	5	10	0.35	8.3	3.07	1.8	2.1	47000	NA	μG/KG		
Endosulfan sulfate	1	10	0.36	0.36	0.36	2.5	2.8	47000	NA	μG/KG		
Endrin	1	10	1.2	1.2	1.2	3	3.3	2300	NA	μG/KG		
Endrin aldehyde	8	10	1.4	8.9	3.69	1.3	1.3	2300	NA	μG/KG		
gamma-BHC (Lindane)	1	10	1.4	1.4	1.4	0.58	1.4	490	NA	μG/KG		
Heptachlor epoxide	5	10	2.6	49	15.1	1.2	4.3	70	NA	μG/KG		
Methoxychlor	3	10	1.9	5	3.93	4.3	4.8	39000	NA	μG/KG		
Herbicides												
2,4,5-T	1	2	8.1	8.1	8.1	30	30	78000	NA	μG/KG		
2,4,5-TP (Silvex)	1	2	2.1	2.1	2.1	30	30	63000	NA	μG/KG		
2,4-D	1	2	28	28	28	100	100	78000	NA	μG/KG		
Semivolatile Organics												
2-Methylnaphthalene	3	36	15	34	24	420	1200	310000	NA	μG/KG		
3-Methylphenol (m-Cresol)	1	15	160	160	160	1400	1800	390000	NA	μG/KG		
4-Methylphenol (p-Cresol)	1	36	160	160	160	420	1800	39000	NA	μG/KG		
Acenaphthene	3	36	20	160	68	420	920	470000	NA	μG/KG		
Anthracene	6	36	19	200	62	420	1000	2300000	NA	μG/KG		
Benzo(g,h,i)perylene	8	36	31	1300	236	420	860	310000	NA	μG/KG		
bis(2-Ethylhexyl)phthalate (BEHP)	9	36	57	930	251	420	1000	46000	NA	μG/KG		
Butylbenzylphthalate	1	36	61	61	61	420	950	1600000	NA	μG/KG		
Dibenzofuran	1	36	49	49	49	420	960	31000	NA	μG/KG		
Fluoranthene	23	36	18	2600	271	420	1300	310000	NA	μG/KG		
Fluorene	2	36	22	80	51	420	960	310000	NA	μG/KG		

Table 10.7.7
Chemicals Present in Site Samples
AOC 685 - Surface Soil
Charleston Naval Complex
Charleston, South Carolina

Parameter	Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration Residential RBC	Background	Units	Number Exceeding RBC	Background
Naphthalene	4	36	28	100	55.8	420	920	310000	NA	µG/KG		
Pentachlorophenol	1	36	45	45	45	1500	3300	5300	NA	µG/KG		
Phenanthrene	20	36	34	1000	152	420	860	230000	NA	µG/KG		
Pyrene	26	36	17	2800	247	420	1000	230000	NA	µG/KG		
Volatile Organics												
Acetone	2	10	26	36	31	23	130	780000	NA	µG/KG		
Toluene	4	10	1	6	3.75	17	21	1600000	NA	µG/KG		
Trichlorotrifluoroethane (Freon 113)	2	10	4	15	9.5	12	14	230000000	NA	µG/KG		
TPH												
Petroleum Hydrocarbons, TPH	1	1	4.8	4.8	4.8	NA	NA	NA	NA	MG/KG		
TCDD Equivalents												
Dioxin (TCDD Equivalents)	2	2	0.134	0.538	0.336	NA	NA	4.3	NA	NG/KG		

Notes:
* - Indicates chemical was identified as a COPC
N - Indicates chemical is an essential nutrient
SQL - Sample quantitation limit
RBC - Risk-based concentration
µG/KG - micrograms per kilogram
MG/KG - milligrams per kilogram
NG/KG - nanograms per kilogram
NA - Not applicable or not available
ND - Not determined due to lack of information

The future site worker scenario assumed continuous exposure to surface soil. Exposure for current site workers would be less than this because there is currently limited soil contact. Therefore, the future worker scenario is considered to be conservatively representative of current site worker exposure.

Exposure Pathways

Exposure pathways for the hypothetical future site residents are dermal contact and incidental ingestion of surface soils. The exposure pathways for future site workers are the same. In addition, the future site worker scenario assumed continuous exposure to surface soils. Uniform exposure was assumed for all sample locations. Table 10.7.8 presents the justification for assessing particular exposure pathways in this HHRA.

Exposure Point Concentrations

As discussed in Section 7 of this RFI, UCLs were calculated for data sets consisting of at least 10 samples. UCLs were calculated for surface soil COPCs at AOC 685, as summarized in Table 10.7.9. The UCLs were applied as the EPCs for benzo(a)pyrene equivalents, aluminum, antimony, arsenic, chromium, copper, lead, manganese, thallium, and vanadium.

Quantification of Exposure

Soil

CDIs for ingestion and dermal contact with soils are shown in Tables 10.7.10 and 10.7.11, respectively.

Table 10.7.8
AOC 685
Exposure Pathways Summary

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Current Land Uses			
Current Users (Site Workers)	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	This exposure pathway was considered insignificant compared to the other pathways.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Shallow groundwater is not currently used as a source of potable or non-residential water at AOC 685.
	Shallow groundwater, Inhalation of volatilized groundwater contaminants	No	Shallow groundwater is not currently used as a source of potable or non-residential water at AOC 685.
	Soil, Incidental ingestion	No (Qualified)	Future site use is considered conservatively representative of current receptors.
	Soil, Dermal contact	No (Qualified)	Future site use is considered conservatively representative of current receptors.
Future Land Uses			
Future Site Residents (Child and Adult), Future Site Worker	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	This exposure pathway was considered insignificant compared to the other pathways.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Shallow groundwater, Inhalation of volatilized contaminants during domestic use	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Soil, Incidental ingestion	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.
	Soil, Dermal contact	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.
	Wild game or domestic animals, Ingestion of tissue impacted by media contamination	No	Hunting/taking of game and/or raising livestock is prohibited within the Charleston, South Carolina city limits.
	Fruits and vegetables, Ingestion of plant tissues grown in media	No	The potential for significant exposure via this pathway is low relative to that of other exposure pathways assessed.

Table 10.7.9
Statistical Analysis of COPCs
Surface Soils at AOC 685
Charleston Naval Complex
Charleston, South Carolina

		Natural Log Transformed			UCL	MAX	EPC	
COPC	n	mean	SD	H-stat	(mg/kg)	(mg/kg)	(mg/kg)	
Benzo(a)pyrene Equivalents	36	-0.648	0.462	1.888	0.67	3.75	0.67	UCL
Aluminum	36	9.737	0.353	1.817	20090	29900	20090	UCL
Antimony	36	-0.478	1.241	2.686	2.4	21.4	2.4	UCL
Arsenic	36	2.401	0.390	1.839	13.4	30.3	13.4	UCL
Chromium	36	3.738	0.334	1.805	49.2	83.5	49.2	UCL
Copper	36	4.167	1.146	2.571	205	494	205	UCL
Lead	36	4.535	1.126	2.547	285	1110	285	UCL
Manganese	36	5.961	0.730	2.112	657	1920	657	UCL
Thallium	36	-1.082	0.432	1.867	0.43	0.71	0.43	UCL
Vanadium	36	3.560	0.503	1.917	46.9	74.5	46.9	UCL

Notes:

mean arithmetic mean of the logtransformed data
n number of samples analyzed
SD standard deviation for a sample of data
H-stat "H" statistic from Gilbert 1987; cuboidal interpolation was used to determine the value in accordance with *USEPA Supplemental Guidance to RAGS, Calculating the Concentration Term*
EPC exposure point concentration
UCL 95 percentile upper confidence level mean
MAX maximum reported concentration

Table 10.7.10
Chronic Daily Intakes
Incidental Ingestion of Surface Soil
AOC 685
Charleston Naval Complex
Charleston, South Carolina

Chemical	Fraction Ingested from Contaminated Source*	Exposure Point Concentration (mg/kg)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident LWA C-CDI (mg/kg-day)	Future Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Benzo(a)pyrene Equivalents	1	0.67	9.24E-07	8.63E-06	1.06E-06	3.30E-07	1.18E-07
Aluminum	1	20090	2.75E-02	2.57E-01	3.15E-02	9.83E-03	3.51E-03
Antimony	1	2.35	3.22E-06	3.01E-05	3.68E-06	1.15E-06	4.11E-07
Arsenic	1	13.4	1.84E-05	1.72E-04	2.11E-05	6.58E-06	2.35E-06
Chromium	1	49.2	6.74E-05	6.29E-04	7.70E-05	2.41E-05	8.60E-06
Copper	1	205	2.80E-04	2.62E-03	3.21E-04	1.00E-04	3.58E-05
Lead	1	285	3.91E-04	3.65E-03	4.47E-04	1.40E-04	4.99E-05
Manganese	1	657	9.00E-04	8.40E-03	1.03E-03	3.21E-04	1.15E-04
Thallium	1	0.43	5.84E-07	5.45E-06	6.67E-07	2.08E-07	7.45E-08
Vanadium	1	46.90	6.42E-05	6.00E-04	7.34E-05	2.29E-05	8.19E-06

Notes:

LWA Lifetime-weighted average; used to calculate carcinogenic CDI, *RAGS Parts A and B*

CDI Chronic daily intake in mg/kg-day

H-CDI CDI for hazard quotient

C-CDI CDI for excess cancer risk

* Reflects the estimated fraction of the site impacted by the corresponding COPC

Table 10.7.11
Chronic Daily Intakes
Dermal Contact with Surface Soil
AOC 685
Charleston Naval Complex
Charleston, South Carolina

Chemical	Exposure Point Concentration (mg/kg)	Fraction Contacted from Contaminated Source *	Dermal Absorption Factor+ (unitless)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident LWA C-CDI (mg/kg-day)	Future Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Benzo(a)pyrene Equivalent	0.67	1	0.01	3.79E-07	1.25E-06	2.37E-07	2.71E-07	9.67E-08
Aluminum	20090	1	0.001	1.13E-03	3.72E-03	7.06E-04	8.06E-04	2.88E-04
Antimony	2.35	1	0.001	1.32E-07	4.36E-07	8.27E-08	9.43E-08	3.37E-08
Arsenic	13.4	1	0.001	7.55E-07	2.49E-06	4.73E-07	5.39E-07	1.93E-07
Chromium	49.2	1	0.001	2.76E-06	9.12E-06	1.73E-06	1.97E-06	7.05E-07
Copper	205	1	0.001	1.15E-05	3.80E-05	7.20E-06	8.21E-06	2.93E-06
Lead	285	1	0.001	1.60E-05	5.29E-05	1.00E-05	1.14E-05	4.09E-06
Manganese	657	1	0.001	3.69E-05	1.22E-04	2.31E-05	2.64E-05	9.41E-06
Thallium	0.43	1	0.001	2.39E-08	7.90E-08	1.50E-08	1.71E-08	6.11E-09
Vanadium	46.90	1	0.001	2.63E-06	8.69E-06	1.65E-06	1.88E-06	6.72E-07

Notes:
CDI Chronic daily intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
\+ The dermal absorption factor was applied to the exposure point concentration to reflect the different trans-dermal migration of inorganic versus organic chemicals
* Reflects the estimated fraction of the site impacted by the corresponding COPC
LWA Lifetime-weighted average

10.7.6.4 Toxicity Assessment

Toxicity assessment terms and methods are discussed in Section 7 of this report. Table 10.7.12 presents toxicological information specific to each COPC identified at AOC 685. This information was used in the quantification of risk/hazard associated with soil contaminants. Brief toxicological profiles for each COPC are provided in the following paragraphs.

Aluminum is one of the most abundant metals in the earth's crust and it is ubiquitous in air, water, and soil. This metal is water-soluble, silvery, and ductile, which suggests its usefulness in many processes. Ingesting aluminum can affect the absorption of other elements within the gastrointestinal tract and can alter intestinal function. Aluminum can interfere with the absorption of essential nutrients and cholesterol. Another effect on the gastrointestinal system is the inhibition of acetylcholine-induced contractions, which are part of the neuro-muscular system controlling bowel muscles. (The effect could explain why aluminum-containing antacids often produce constipation and indicates that aluminum could affect the uptake of other chemicals.) Aluminum dust is moderately flammable and explosive in heat. Inhaling this dust can cause fibrosis (aluminosis) (Klaasen, et al., 1986; Dreisbach, et al., 1987). No data are available on an applicable SF or the USEPA cancer group. The USEPA Region IV Office of Health Assessment has suggested using the provisional oral RfD of 1.0 mg/kg-day. The aesthetic-based secondary MCL (SMCL) for drinking water is 50 to 200 μg/L.

Antimony is absorbed slowly through the gastrointestinal tract, which is the target of this element. Another target is the blood, where antimony concentrates. Due to frequent industrial use, the primary exposure route for antimony to the general population is ingestion. Antimony is also a common air pollutant from industrial emissions. USEPA has not classified antimony as a carcinogen, and the oral RfD is 0.0004 mg/kg-day (Klaasen, et al., 1986). The oral RfD is based on a LOAEL of 0.35 mg/kg-day, an uncertainty factor of 1,000, and a modifying factor of 1 (IRIS, 1995).

Table 10.7.12
Toxicological Reference Information
for Chemicals of Potential Concern
AOC 685
Charleston Naval Complex
Charleston, South Carolina

	Non-Carcinogenic Toxicity Data								*Carcinogenic Toxicity Data*			
Chemical	**Oral Reference Dose (mg/kg-day)**	**Confidence Level**	**Critical Effect**	**Uncertainty Factor Oral**	**Inhalation Reference Dose (mg/kg-day)**	**Confidence Level**	**Critical Effect**	**Uncertainty Factor Inhalation**	**Oral Slope Factor (kg-day/mg)**	**Inhalation Slope Factor (kg-day/mg)**	**Weight of Evidence**	**Tumor Type**
Aluminum	1 c	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Antimony	0.0004 a	L	whole body/blood increased mortality	1,000	NA	NA	NA	NA	NA	NA	D	NA
Arsenic	0.0003 a	M	hyperpigmentation	3	NA	NA	NA	NA	1.5 a	15.1 a	A	various
BEQ	NA	NA	NA	NA	NA	NA	NA	NA	7.3 a	3.1 c	B2	mutagen
Chromium III	1 a	L	NA	100/10	NA	NA	NA	NA	NA	NA a	D	NA
Chromium VI	0.005 a	L	NA	500	1E-07 c	NA	NA	NA	NA	41 a	A	lung
Copper	0.04 b	NA	NA	NA	NA	NA	NA	NA	NA	NA	D	NA
Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	B2	various
Manganese (food)	0.14 a	M	neurological effects	1	1.43E-05 a	M	neurological effects	1000	NA	NA	D	NA
Manganese (water)	0.023 a	M	neurological effects	1	1.43E-05 a	M	neurological effects	1000	NA	NA	D	NA
Thallium	7E-05 d	L	increased SGOT (liver) increased serum L	3000	NA	NA	NA	NA	NA	NA	D	NA
Vanadium	0.007 b	NA	unclear	100	NA	NA	NA	NA	NA	NA	D	NA

Notes:

a = Integrated Risk Information System (IRIS)
b = Health Effects Assessment Summary Tables (HEAST)
c = EPA NCEA - Cincinnati (provisional)
d = RfDo for thallium sulfate corrected for the difference in molecular weight between thallium and thallium sulfate
NA = Not applicable or not available
L = Low confidence
M = Medium confidence

Arsenic exposure via the ingestion route causes darkening and hardening of the skin in chronically exposed humans. Inhalation exposure to arsenic causes neurological deficits, anemia, and cardiovascular effects (Klaasen, et al., 1986). USEPA set 0.3 μg/kg-day as the RfD for arsenic based on a NOAEL of 0.8 μg/kg-day in a human exposure study. The effects of arsenic on the nervous and cardiovascular systems are primarily associated with acute exposure to higher levels. Exposure to arsenic-containing materials has been shown to cause cancer in humans. Inhalation of these materials can lead to increased lung cancer risk, and ingestion of these materials is associated with increased skin cancer rates. Arsenic has been classified as a group A carcinogen by USEPA, who established the 1.5 $(mg/kg\text{-}day)^{-1}$ SF. As listed in IRIS, the basis for the classification is sufficient evidence from human data. An increased lung cancer mortality was observed in multiple human populations exposed primarily through inhalation. Also, increased mortality from multiple internal organ cancers (liver, kidney, lung, and bladder) and an increased incidence of skin cancer were observed in populations consuming drinking water high in inorganic arsenic. Human milk contains about 3 μg/L arsenic. The tap-water RBC for arsenic is 0.045 μg/L. As listed in IRIS, the critical effects of this chemical are hyperpigmentation, keratosis, and possible vascular complications. The uncertainty factor was determined to be 3 and the modifying factor was determined to be 1.

Benzo(a)pyrene equivalents include the following polynuclear aromatic hydrocarbons (PAHs):

Benzo(a)anthracene	TEF 0.1
Benzo(a)pyrene	TEF 1.0
Benzo(b)fluoranthene	TEF 0.1
Benzo(k)fluoranthene	TEF 0.01
Chrysene	TEF 0.001
Dibenz(a,h)anthracene	TEF 1.0
Indeno(1,2,3-cd)pyrene	TEF 0.1

Some PAHs are toxic to the liver, kidney, and blood. However, the toxic effects of the listed PAHs have not been well established, and there are no RfDs for these PAHs due to a lack of data. All PAHs listed above are classified by USEPA as B2 carcinogens, and their carcinogenicity is addressed relative to that of benzo(a)pyrene, which has an oral SF of 7.3 $(mg/kg\text{-}day)^{-1}$. TEFs, also set by USEPA, are multipliers applied to the detected concentrations, which are subsequently used to calculate excess cancer risk. These multipliers are discussed further in the exposure and toxicity assessment sections. Most carcinogenic PAHs have been so classified due to animal studies using large doses of purified PAHs. There is some doubt as to the validity of these listings, and the SFs listed in USEPA's RBC table are provisional. However, these PAHs are carcinogens when the exposure involves a mixture of other carcinogenic substances (e.g., coal tar, soot, or cigarette smoke). As listed in IRIS, human data that specifically link benzo(a)pyrene to a carcinogenic effect are lacking. There are, however, multiple animal studies in many species demonstrating benzo(a)pyrene to be carcinogenic by numerous routes.

Benzo(a)pyrene has produced positive results in numerous genotoxicity assays. At the June 1992 CRAVE Work Group meeting, a revised risk estimate of benzo(a)pyrene was verified. This section provides information on the aspects of the carcinogenic risk assessment for the agent in question: the USEPA classification and quantitative estimates of exposure. The classification reflects a weight-of-evidence judgment of the likelihood that the agent is a human carcinogen. The quantitative risk estimates are presented in application of a low-dose extrapolation procedure and presented as the risk per mg/kg-day. The unit risk is the quantitative estimate in terms of either risk per $\mu g/L$ drinking water or risk per $\mu g/m^3$ air breathed. The third form in which risk is presented is drinking water or air concentration providing cancer risks of 1 in 10,000 or 1 in 1,000,000. The Carcinogenicity Background Document provides details on the carcinogenicity values found in IRIS. Users are referred to the Oral Reference Dose and Reference Concentration sections for information on long-term toxic effects other than carcinogenicity.

As listed in IRIS, the basis for the dibenz(a,h)anthracene and benzo(b)fluoranthene B2 classification is no human data and sufficient data from animal bioassays. Benzo(b)fluoranthene produced tumors in mice after lung implantation, intraperitoneal or subcutaneous injection, and skin painting. As listed in IRIS, the basis for the benzo(a)anthracene B2 classification is no human data and sufficient data from animal bioassays. Benzo(a)anthracene produced tumors in mice exposed by gavage; intraperitoneal, subcutaneous or intramuscular injection; and topical application. Benzo(a)anthracene produced mutations in bacteria and in mammalian cells, and transformed mammalian cells in culture. As listed in IRIS, the basis for the benzo(k)fluoranthene B2 classification is no human data and sufficient data from animal bioassays. Benzo(k)fluoranthene produced tumors after lung implantation in mice and when administered with a promoting agent in skin-painting studies. Equivocal results have been found in a lung adenoma assay in mice. Benzo(k)fluoranthene is mutagenic in bacteria. (Klaasen, et al., 1986).

Chromium exists in two stable, natural forms: CrIII and hexavalent CrVI. Acute exposure to chromium can result in kidney damage following oral exposure, or damage to the nasal mucosa and septum following inhalation exposure. Chronic inhalation exposure to CrVI has resulted in kidney and respiratory tract damage, as well as excess lung cancer in both animals and humans following occupational exposure. Only CrVI is believed to be carcinogenic by inhalation (IRIS). Oral RfD values for CrIII and CrVI are 1.0 and 5E-03 (mg/kg-day), respectively. For CrVI, the RfD is based on liver toxicity in rats. For CrVI, the RfD is based on unspecified pathological changes observed in rat studies. In addition, CrVI is considered a group A carcinogen for inhalation exposures, and an inhalation SF of 41 $(mg/kg\text{-}day)^{-1}$ has been established for the hexavalent form. Vitamin supplements contain approximately 0.025 mg of chromium. As listed in IRIS, no critical effects were observed for CrIII. The uncertainty factor was 100 and the modifying factor was 10. As listed in IRIS, no critical effects were observed for CrVI. The uncertainty factor was 500 and the modifying factor was 1.

Copper is a nutritionally essential element, necessary for many of the body's enzymes. In the past, lead pipes and solder were used for residential water pipes, and resulting lead concentrations in drinking water exceeded USEPA guidelines. Copper has been used to replace water pipes in residences since it is less toxic to man. Short-term exposure to copper can result in anemia (the lack of iron), the breakdown of red blood cells, and liver and kidney lesions. The target organs for copper are the liver, kidney, and red blood cell. Vitamin C reduces copper uptake from the gut, and other substances can also influence copper uptake. Copper fumes can cause metal fume fever (Klaasen, et al., 1986). As listed in IRIS, the D classification is based on no human data, inadequate animal data from assays of copper compounds, and equivocal mutagenicity data. The USEPA RfD is 0.0371 mg/kg-day, which is 2.6 mg/day for the average adult (weighing 70 kg). In typical vitamin supplements, 2 mg/day is the typical dose (NRC, 1989).

Lead has been classified as a group B2 carcinogen by USEPA based on animal data. No RfD or SF has been set by USEPA. However, an action level for soil protective of child residents, 400 mg/kg, has been proposed by USEPA Region IV. USEPA's OSWER has recommended a 1,000 mg/kg cleanup standard for industrial properties. USEPA's Office of Water has established a treatment action level of 15 μg/L. As listed in IRIS, the classification is based on sufficient animal evidence. Ten rat bioassays and one mouse assay have shown statistically significant increases in renal tumors with dietary and subcutaneous exposure to several soluble lead salts. Animal assays provide reproducible results in several laboratories, in multiple rat strains with some evidence of multiple tumor sites. Short-term studies show that lead affects gene expression. Human evidence is inadequate.

An RfD and SF have not been set because of the confounding nature of lead toxicity. Lead can accumulate in bone marrow, and effects have been observed in the CNS, blood, and mental development of children. RfDs are based on the assumption that a threshold must be exceeded to result in toxic effects (other than carcinogenicity). Once lead accumulates in the body, other influences cause the actual levels in the blood to fluctuate; sometimes the lead is attached to binding sites; sometimes lead is free flowing. If an exposed individual has previously been exposed to lead, the individual could lose weight and free fat-bound lead. This fluctuation and lack of previous lead exposure data are two of the reasons lead effects are difficult to predict (Klaasen, et al., 1986).

Manganese is an essential nutrient, but chronic exposure (0.8 mg/kg-day) causes mental disturbances. Studies have shown that manganese uptake from water is greater than manganese uptake from food, and the elderly appear to be more sensitive than children (Klaasen et al., 1986; Dreisbach et al., 1987). USEPA determined the RfD to be 0.14 mg/kg-day based on dietary uptake. USEPA recommended using a modifying factor of 3 when estimating intake from water. In addition, the body absorbs roughly twice as much manganese in water as it does manganese in food. Because of the different uptake rates in water and food, two RfDs were used in this HHRA — one for water and one for food. The RfDs used are 0.047 and 0.023 mg/kg-day, respectively. Inhalation of manganese dust causes neurological effects and increased incidence of pneumonia. An inhalation RfD was set to 1.43E-05 mg/kg-day. According to USEPA, manganese cannot be classified as to its carcinogenicity. Therefore, its cancer class is group D. As listed in IRIS, this classification is based on studies that are inadequate to assess the carcinogenicity of manganese. Manganese is considered essential to human health; the typical vitamin supplement dose is 2.5 mg/day. As listed in IRIS, the critical effects of this chemical in water in the oral summary are CNS effects. The uncertainty factor was 1 and the recommended modifying factor of 3 was used to estimate soil and groundwater intake. As listed in IRIS, the critical effect of manganese in the inhalation summary is neuro-behavioral impairment. For inhalation uptake, the uncertainty factor was 1,000 and the modifying factor was 1. The IRIS RfC is 5E-05 mg/m^3.

Thallium is readily absorbed through the gut and skin. Primary effects are stomach and bowel disturbances, kidney and liver damage, and neurological disturbances. Thallium was used in the past as a rodenticide and ant killer, uses now prohibited. This element remains in the body for a relatively long time and could accumulate if the chronic dose is large. USEPA's oral RfD for thallium is 8E-05 mg/kg-day (Klaasen, et al., 1986; Dreisbach, et al., 1987). The uncertainty factor used for thallium is 3,000.

Vanadium is not readily absorbed through the skin or via oral ingestion, and is a ubiquitous element. It is also a by-product of petroleum refining. Vanadium is soluble in fats and oils (Klaasen et al., 1986). Municipal water supplies contain 0.001 to 0.006 mg/L. The target organ is unclear, and the primary focus of toxicological information is inhalation of vanadium dust. Vitamin supplements contain approximately 0.010 mg in a daily dose. The oral RfD set by USEPA is 0.007 mg/kg-day. The uncertainty factor used for vanadium is 100.

10.7.6.5 Risk Characterization

Surface Soil Pathways

Exposure to surface soil was evaluated under both future residential and industrial (site worker) scenarios. For each scenario, the incidental ingestion and dermal contact exposure pathways were evaluated. For noncarcinogenic contaminants evaluated for future site residents, hazard was computed separately to address child and adult exposures. Tables 10.7.13 and 10.7.14 present the computed carcinogenic risks and/or HQs associated with the incidental ingestion of and dermal contact with site surface soils, respectively.

AOC 685 is a weed-covered lot with some exposed soil. Because there are no current operations at this site, base personnel do not have frequent opportunity for exposure. Should site use remain the same in the future, the risk/hazard projections discussed below would be gross overestimates.

Hypothetical Site Residents

The ingestion ILCR (based on the adult and child lifetime-weighted average) for AOC 685 surface soils is 4E-5, and the dermal pathway ILCR is 7E-6. The computed hazard indices for the adult and child resident were 0.1 and 1, respectively, for the soil ingestion pathway. The dermal

Table 10.7.13
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
AOC 685
Charleston Naval Complex
Charleston, South Carolina

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used $(mg/kg\text{-}day)^{-1}$	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident LWA ILCR	Future Worker adult Hazard Quotient	Future Worker adult ILCR
Benzo(a)pyrene Equivalents	NA	7.3	ND	ND	7.7E-06	ND	8.6E-07
Aluminum	1	NA	0.028	0.26	ND	0.0098	ND
Antimony	0.0004	NA	0.0081	0.075	ND	0.0029	ND
Arsenic	0.0003	1.5	0.061	0.57	3.2E-05	0.022	3.5E-06
Chromium	0.005	NA	0.013	0.13	ND	0.0048	ND
Copper	0.04	NA	0.0070	0.065	ND	0.0025	ND
Lead	NA	NA	ND	ND	ND	ND	ND
Manganese	0.14	NA	0.0064	0.060	ND	0.0023	ND
Thallium	0.00007	NA	0.0083	0.078	ND	0.0030	ND
Vanadium	0.007	NA	0.0092	0.086	ND	0.0033	ND
SUM Hazard Index/ILCR			0.1	1	4E-05	0.05	4E-06

Notes:
NA Not available
ND Not Determined due to lack of available information
LWA Lifetime-weighted average; used to calculate excess carcinogenic risk derived from *RAGS Part A*
ILCR Incremental lifetime excess cancer risk

Table 10.7.14
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
AOC 685
Charleston Naval Complex
Charleston, South Carolina

Chemical	Dermal Adjustment	Oral RfD Used (mg/kg-day)	Oral SF Used $(mg/kg\text{-}day)^{-1}$	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident LWA ILCR	Future Worker adult Hazard Quotient	Future Worker adult ILCR
Benzo(a)pyrene Equivalents	0.5	NA	14.6	ND	ND	3.5E-06	ND	1.4E-06
Aluminum	0.2	0.2	NA	0.0056	0.019	ND	0.0040	ND
Antimony	0.2	0.00008	NA	0.0017	0.0054	ND	0.0012	ND
Arsenic	0.2	0.00006	7.5	0.013	0.042	3.5E-06	0.0090	1.4E-06
Chromium	0.2	0.001	NA	0.0028	0.0091	ND	0.0020	ND
Copper	0.2	0.008	NA	0.0014	0.0047	ND	0.0010	ND
Lead	0.2	NA	NA	ND	ND	ND	ND	ND
Manganese	0.2	0.028	NA	0.0013	0.0043	ND	0.00094	ND
Thallium	0.2	0.000014	NA	0.0017	0.0056	ND	0.0012	ND
Vanadium	0.2	0.001400	NA	0.0019	0.0062	ND	0.0013	ND
SUM Hazard Index/ILCR				0.03	0.1	7E-06	0.02	3E-06

Notes:
NA Not available
ND Not determined due to lack of available information
LWA Lifetime-weighted average; used to calculate excess carcinogenic risk derived from *RAGS Part A*
ILCR Incremental lifetime excess cancer risk
- Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)

contact pathway hazard indices were 0.03 and 0.1 for the adult resident and the child resident, respectively. Arsenic was the primary contributor to risk projections, with benzo(a)pyrene equivalents contributing to a lesser extent. Aluminum, arsenic, and chromium were the principal contributors to hazard index projections.

Future Site Workers

Site worker ILCRs are 4E-6 and 3E-6 for the ingestion and dermal contact pathways, respectively. The hazard indices for both pathways were less than 0.1. Arsenic was the primary contributor to ILCR, with benzo(a)pyrene equivalents contributing to a lesser extent.

Lead Toxicity

At AOC 685, four surface soil samples were found to contain lead at concentrations exceeding the residential cleanup goal of 400 mg/kg. These samples were 685SB008 (459 mg/kg), 685SB009 (949 mg/kg), 685SB024 (602 mg/kg), and 685SB030 (1,110 mg/kg). The mean lead concentration at AOC 685 is 179 mg/kg. Because the mean falls below the residential cleanup goal, chronic exposures are not expected to pose a significant health threat.

COCs Identified

USEPA has established a generally acceptable risk range of 1E-04 to 1E-06, and a hazard index threshold of 1.0 (unity). As recommended by SCDHEC, a COC was considered to be any chemical contributing to a cumulative risk level of 1E-06 or greater and/or a cumulative hazard index above 1.0, and whose individual ILCR exceeds 1E-06 or whose hazard quotient exceeds 0.1. For carcinogens, this approach is relatively conservative, since a cumulative risk level of 1E-04 (and individual ILCR of 1E-06) is recommended by USEPA Region IV as the trigger for establishing COCs. The specified COC selection algorithm was used in order to provide a more comprehensive evaluation of chemicals contributing to carcinogenic risk or noncarcinogenic hazard during the development of remedial goal options. Table 10.7.15 summarizes the COCs identified for AOC 685.

Surface Soils

Hypothetical Site Residents (future land use)

Benzo(a)pyrene equivalents and arsenic were identified as COCs based on their contribution to the cumulative ILCR projections. Aluminum, arsenic, and chromium were identified based on contribution to hazard indices.

Future Site Workers (current land use)

Benzo(a)pyrene equivalents and arsenic were identified as soil pathway COCs based on their contributions to cumulative ILCR projections.

The extent of the COCs identified in surface soil is discussed briefly below. To facilitate evaluation of the extent of COC concentrations, a comparison was made to the background concentrations. Arsenic was detected in one sample above its background concentration. Aluminum was detected in three samples above its background concentration. Chromium was detected in 26 samples above its background concentration. Overall onsite arsenic, aluminum, and chromium values were significantly higher than background, as determined by Wilcoxon rank sum test analysis. These elements were detected in all 36 surface soil samples. Benzo(a)pyrene equivalents were detected in 23 of 36 surface soil samples. The residential RBC was exceeded in 15 of 36 samples, and exceedances were widely distributed across the site.

10.7.6.6 Risk Uncertainty

Characterization of Exposure Setting and Identification of Exposure Pathways

The potential for high bias in exposure assessment is introduced through exposure setting and pathway selection due to the highly conservative assumptions (i.e., future residential use)

Table 10.7.15
Summary of Risk and Hazard-based COCs
AOC 685
Charleston Naval Complex
Charleston, South Carolina

Medium	Exposure Pathway		Future Resident Adult Hazard Quotient	Future Resident Child Hazard Quotient	Future Resident LWA ILCR	Future Site Worker Hazard Quotient	Future Site Worker ILCR	Identification of COCs		
Surface Soil	Incidental Ingestion	Benzo(a)pyrene Equivalents	ND	ND	7.7E-06	ND	8.6E-07		2	
		Aluminum	0.028	0.26	ND	0.010	ND	1		
		Antimony	0.0081	0.075	ND	0.0029	ND			
		Arsenic	0.061	0.57	3.2E-05	0.022	3.5E-06	1	2	4
		Chromium	0.013	0.13	ND	0.0048	ND	1		
		Copper	0.0070	0.065	ND	0.0025	ND			
		Lead	ND	ND	ND	ND	ND			
		Manganese	0.0064	0.060	ND	0.0023	ND			
		Thallium	0.0083	0.078	ND	0.0030	ND			
		Vanadium	0.0092	0.086	ND	0.0033	ND			
	Dermal Contact	Benzo(a)pyrene Equivalents	ND	ND	3.5E-06	ND	1.4E-06		2	4
		Aluminum	0.0056	0.019	ND	0.0040	ND			
		Antimony	0.0017	0.0054	ND	0.0012	ND			
		Arsenic	0.013	0.042	3.5E-06	0.0090	1.4E-06		2	4
		Chromium	0.0028	0.0091	ND	0.0020	ND			
		Copper	0.0014	0.0047	ND	0.0010	ND			
		Lead	ND	ND	ND	ND	ND			
		Manganese	0.0013	0.0043	ND	0.0009	ND			
		Thallium	0.0017	0.0056	ND	0.0012	ND			
		Vanadium	0.0019	0.0062	ND	0.0013	ND			
Surface Soil Pathway Sum			0.2	1	5E-05	0.07	7E-06			

Notes:
ND = not determined due to the lack of available information
ILCR = incremental excess lifetime cancer risk
LWA = Lifetime-weighted average
1- Chemical is a COC by virtue of projected resident child non-carcinogenic hazard.
2- Chemical is a COC by virtue of projected future resident lifetime ILCR.
4- Chemical is a COC by virtue of projected future site worker ILCR.
Benzo(a)pyrene equivalents and beryllium were identified as COCs for surface soil based on combined ingestion and dermal contact pathway risk.

recommended by USEPA Region IV. The exposure assumptions made in the future site worker scenario are highly conservative and would tend to overestimate exposure. AOC 685 is vegetated with weeds and wild grasses with some exposed soil areas. AOC 685 is located away from most operations and facilities, and CNC personnel and site workers would not be expected to visit the site frequently.

Residential use of the site is not expected or likely, based on current site uses and the nature of surrounding buildings. Current reuse plans call for continued nonresidential use of Zone I, and AOC 685 is slated to be maintained as an undeveloped open buffer area. If this area were to be used as a residential site, surface soil conditions would likely change. For example, the soils would be covered with landscaping soil and/or a house. Compared to other sites, however, the amount of required regrading and filling would be minimal at AOC 685. Consequently, exposure to current surface soil conditions is possible under a future residential scenario. The affected surface soil would likely account for a fraction of the total potential exposure area. As a result, chronic exposure to identified COCs at the EPC is doubtful. These factors indicate that exposure pathways assessed in this HHRA generally overestimate the risk and hazard posed to current site workers and future site residents.

Determination of Exposure Point Concentrations

The exposure point concentration was set equal to the 95% UCL. This is a conservative assumption since it is unlikely that the 95% UCL is exceeded by the true mean concentration.

Frequency of Detection and Spatial Distribution

Arsenic, aluminum, and chromium were detected above corresponding background concentrations. The overall arsenic, aluminum, and chromium data values were statistically higher than background as determined by Wilcoxon rank sum test analysis. These were detected in all 36 of the surface soil samples collected. The UCL values applied as EPCs for these chemicals, except chromium, were well below the corresponding background concentrations.

Benzo(a)pyrene equivalents were detected in 23 of 36 surface soil samples. The residential RBC was exceeded in 15 samples, and the exceedances were widely distributed across the site.

Four of 36 surface soil samples had lead concentrations in excess of 400 mg/kg (685SB008, 685SB009, 685SB024, and 685SB030). These samples were collected in the approximate center of the area of investigation. The mean lead concentration was calculated to be 179 mg/kg, which is well below the residential cleanup goal.

Quantification of Risk/Hazard

Many site-specific factors affect the uncertainty of this assessment and cause upward bias in the risk and hazard estimates. Exposure pathway-specific sources of uncertainty are discussed below.

Soil

Of the CPSSs screened and eliminated from formal assessment, none was reported at a concentration close to its corresponding RBC (i.e., within approximately 10% of the RBC). This minimizes the likelihood of potentially significant cumulative risk/hazard based on the eliminated CPSSs. Vanadium exceeded its RBC, but did not exceed its background concentration. Wilcoxon rank sum test analysis, however, indicated that the overall concentration of this element in AOC 685 surface soil was significantly higher than background. As a result, it was retained for formal assessment.

Although the future land use at this site is unknown, both the future worker and residential exposure scenarios were assessed in this HHRA. As previously discussed, these scenarios would likely lead to overestimates of risk and/or hazard.

Central tendency analysis was not formally performed for AOC 685 surface soil, but a simplified approach was taken to assess the potential influences of CT assumptions. The CT assumption for residential exposure duration is nine years compared, to the 30 year assumption for RME. The CT exposure frequency assumption is 234 days/year, compared to 350 days/year RME. If all other exposure assumptions remain fixed, application of the CT exposure duration and frequency would result in risk projections 80% below the RME. At CT, the residential surface soil pathway-related risk (incidental ingestion and dermal contact) would drop from 5E-05 to 1E-05. However, this is still above the 1E-06 point of departure. The cumulative hazard index for ingestion and dermal contact pathways would fall below unity under CT assumptions.

Chromium exists predominantly in two valence states, in a natural balance between hexavalent chromium and trivalent chromium. Due to the past activities at AOC 685 (incineration of waste materials), conservative assumptions with regard to chromium exposure are warranted. Therefore, all chromium data were assumed to be in the more toxic, hexavalent chromium valence state. Hexavalent chromium was not analyzed for in AOC 685 soil. The RfD for chromium VI is 0.005 mg/kg-day as opposed to 1 mg/kg-day for chromium III. In general, once chromium is released into the environment, it is mostly transformed into its more stable chromium III valence. As a result, HIs based on exposures to chromium in AOC 685 surface soil are considered overestimates.

10.7.6.7 Risk Summary

The risk and hazard posed by contaminants at AOC 685 were assessed for the hypothetical future site worker and future site resident under reasonable maximum exposure assumptions. This HHRA assessed the incidental ingestion and dermal contact pathways for surface soils. Table 10.7.16 presents the risk summary for each pathway/receptor group evaluated for AOC 685.

Table 10.7.16
Summary of Risk and Hazard
AOC 685
Charleston Naval Complex
Charleston, South Carolina

Medium	Exposure Pathway	HI Resident (Adult)	HI Resident (Child)	ILCR Resident (LWA)	HI (Worker)	ILCR (Worker)
Surface Soil	Incidental Ingestion	0.1	1	4E-05	0.05	4E-06
	Dermal Contact	0.03	0.1	7E-06	0.02	3E-06
Sum of All Pathways		0.2	1	5E-05	0.07	7E-06

Notes:
ND = not determined due to the lack of available risk information.
ILCR = incremental excess lifetime cancer risk
HI = hazard index
LWA = Lifetime-weighted average

Soil — Residential Scenario

The residential soil pathway COCs identified for AOC 685 are benzo(a)pyrene equivalents, aluminum, arsenic, and chromium. Figures 10.7.12 and 10.7.13 show point risk and hazard estimates for AOC 685 based on surface soil exposure pathways under a future residential scenario. Table 10.7.17 summarizes the risk and hazard contribution of each COPC at each sample location.

The point risk map is based on the unlikely assumption that a future site resident will be chronically exposed to specific points. Exposure to surface soil conditions would more likely be the result of uniform exposure to the soil conditions of the entire site (or exposure unit area) rather than specific points. Given this, the risk maps and summary tables are useful to illustrate the spatial distribution of the chemicals driving risk estimates.

All sample locations yielded ILCRs that were greater than 1E-06. Arsenic was the primary contributor to risk, and benzo(a)pyrene equivalents were the secondary contributors. Risk estimates at AOC 685 ranged from 2E-05 (685SB019) to 9E-05 (685SB025), with a mean risk estimate of 3E-05.

Aluminum, arsenic, and chromium were primary contributors to hazard estimates at locations that yielded a hazard index above unity. Antimony was secondary contributor. Hazard index estimates ranged from 0.5 (685SB019) to 2.5 (685SB029), with a mean hazard estimate of 1.2.

Soil — Site Worker Scenario

Industrial soil pathway COCs identified for AOC 685 are benzo(a)pyrene equivalents and arsenic. Figure 10.7.14 gives point risk estimates for AOC 685 based on soil exposure pathways under a future site worker/industrial scenario. Table 10.7.18 summarizes the risk and hazard contribution of each COPC at each sample location.

All sample locations yielded ILCRs greater than 1E-06. Arsenic was the primary contributor to risk, and benzo(a)pyrene equivalents were secondary contributors. Risk estimates ranged from 2E-05 (685SB019) to 2E-05 (685SB025), with a mean risk estimate of 5E-06.

Arsenic was the primary contributor to hazard estimates at AOC 685; however, hazard indices did not exceed unity at any location for the industrial scenario. Hazard index estimates ranged from 0.026 (685SB019) to 0.12 (685SB029), with a mean hazard estimate of 0.06.

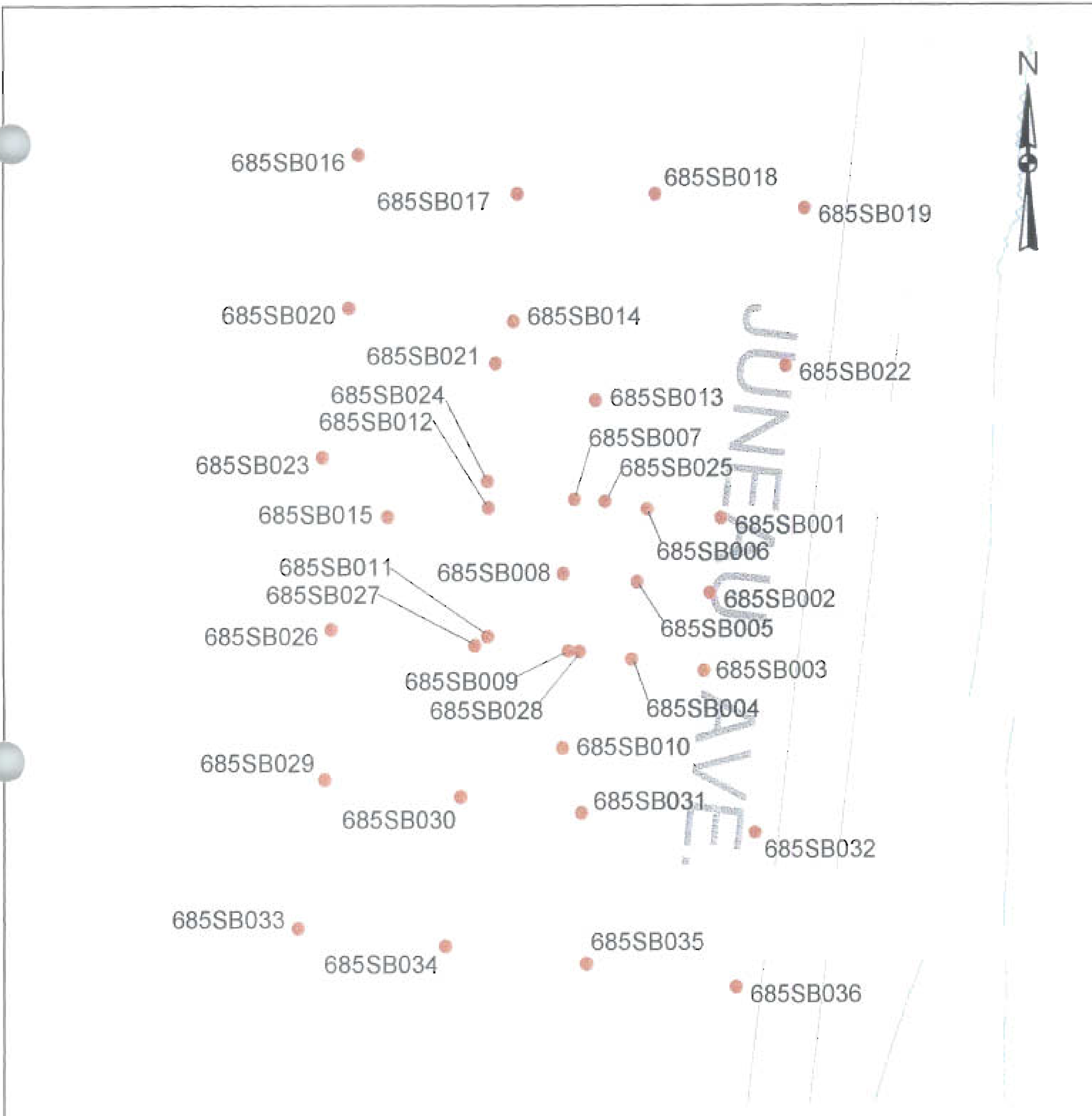
10.7.6.8 Remedial Goal Options

RGOs for carcinogens presented in Table 10.7.19, were based on the lifetime-weighted average future site resident and future site worker for surface soils. Hazard-based RGOs were calculated based on the hypothetical child resident.

10.7.7 Corrective Measures Considerations

Based on the analytical results and the human health risk assessment for AOC 685, COCs requiring further evaluation through the CMS process have been identified for surface soil. The site is in a moderately developed urban setting and risk to human health was evaluated under both future residential and industrial (site worker) scenarios. For these scenarios, the incidental ingestion and dermal contact exposure pathways were evaluated. Hazard was evaluated for noncarcinogenic contaminants through incidental ingestion and dermal contact as well.

As recommended by SCDHEC, a COC is considered to be any chemical contributing to a cumulative risk level of 1E-06 or greater and/or a cumulative hazard index above 1.0, and whose individual risk exceeds 1E-06 or whose hazard quotient exceeds 0.1.



LEGEND

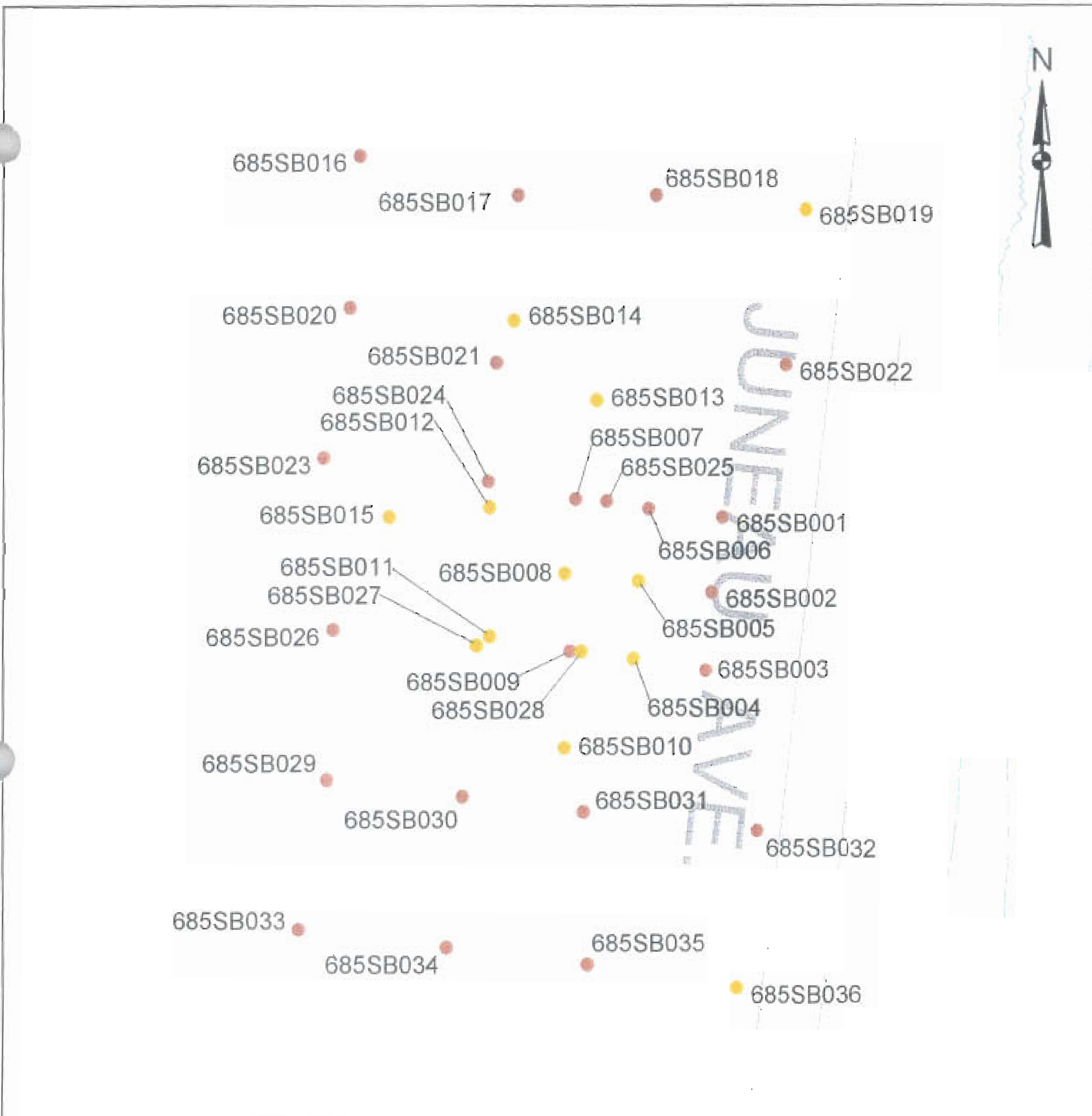
- NO COPCs
- < 1E-6
- 1E-6 to 5E-6
- 5E-6 to 1E-5
- 1E-5 to 1E-4
- > 1E-4

40 0 40 80 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.7.12
ZONE I
AOC 685

SURFACE SOIL POINT RISK
RESIDENTIAL SCENARIO



LEGEND

- NO COPCs
- 0 to 0.1
- 0.1 to 0.5
- 0.5 to 1.0
- 1.0 to 3.0
- > 3.0

40 0 40 80 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.7.13
ZONE I
AOC 685

SURFACE SOIL HAZARD INDEX
RESIDENTIAL SCENARIO

Table 10.7.17
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
AOC 685
Charleston Naval Complex
Charleston, South Carolina

AOC	Location	Parameter	Concentration	Units	Hazard Index	Risk (E-06)
685	B001	Aluminum (Al)	15300.00	MG/KG	0.2098	NA
685	B001	Arsenic (As)	20.70	MG/KG	0.9462	54.07
685	B001	Chromium (Cr)	51.60	MG/KG	0.1415	NA
685	B001	Copper (Cu)	13.40	MG/KG	0.0046	NA
685	B001	Lead (Pb)	24.30	MG/KG	NA	NA
685	B001	Manganese (Mn)	150.00	MG/KG	0.0438	NA
685	B001	Thallium (Tl)	0.71	MG/KG	0.1217	NA
685	B001	Vanadium (V)	34.00	MG/KG	0.0666	NA
				Total	1.5341	54.07
685	B002	Aluminum (Al)	23500.00	MG/KG	0.3222	NA
685	B002	Antimony (Sb)	6.10	MG/KG	0.2091	NA
685	B002	Arsenic (As)	11.80	MG/KG	0.5394	30.82
685	B002	Chromium (Cr)	47.90	MG/KG	0.1314	NA
685	B002	Copper (Cu)	24.10	MG/KG	0.0082	NA
685	B002	Lead (Pb)	29.40	MG/KG	NA	NA
685	B002	Manganese (Mn)	276.00	MG/KG	0.0805	NA
685	B002	Vanadium (V)	42.60	MG/KG	0.0834	NA
				Total	1.3742	30.82
685	B003	Aluminum (Al)	29900.00	MG/KG	0.4100	NA
685	B003	Arsenic (As)	15.50	MG/KG	0.7085	40.49
685	B003	Chromium (Cr)	56.80	MG/KG	0.1558	NA
685	B003	Copper (Cu)	22.00	MG/KG	0.0075	NA
685	B003	Lead (Pb)	36.70	MG/KG	NA	NA
685	B003	Manganese (Mn)	222.00	MG/KG	0.0648	NA
685	B003	Vanadium (V)	55.50	MG/KG	0.1087	NA
				Total	1.4552	40.49
685	B004	Aluminum (Al)	20900.00	MG/KG	0.2866	NA
685	B004	Arsenic (As)	9.20	MG/KG	0.4205	24.03
685	B004	Benzo(a)pyrene Equiv.	23.00	µG/KG	NA	0.38
685	B004	Chromium (Cr)	48.40	MG/KG	0.1327	NA
685	B004	Copper (Cu)	137.00	MG/KG	0.0466	NA
685	B004	Lead (Pb)	63.20	MG/KG	NA	NA
685	B004	Manganese (Mn)	217.50	MG/KG	0.0634	NA
685	B004	Vanadium (V)	43.40	MG/KG	0.0850	NA
				Total	1.0349	24.41
685	B005	Aluminum (Al)	12400.00	MG/KG	0.1700	NA
685	B005	Arsenic (As)	6.20	MG/KG	0.2834	16.19
685	B005	Benzo(a)pyrene Equiv.	59.36	µG/KG	NA	0.98
685	B005	Chromium (Cr)	34.10	MG/KG	0.0935	NA
685	B005	Copper (Cu)	464.00	MG/KG	0.1578	NA
685	B005	Lead (Pb)	306.00	MG/KG	NA	NA
685	B005	Manganese (Mn)	128.00	MG/KG	0.0373	NA
685	B005	Vanadium (V)	25.30	MG/KG	0.0496	NA
				Total	0.7916	17.18

Table 10.7.17
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
AOC 685
Charleston Naval Complex
Charleston, South Carolina

AOC	Location	Parameter	Concentration	Units	Hazard Index	Risk (E-06)
685	B006	Aluminum (Al)	22000.00	MG/KG	0.3017	NA
685	B006	Arsenic (As)	14.80	MG/KG	0.6765	38.66
685	B006	Benzo(a)pyrene Equiv.	5.46	µG/KG	NA	0.09
685	B006	Chromium (Cr)	47.00	MG/KG	0.1289	NA
685	B006	Copper (Cu)	224.00	MG/KG	0.0762	NA
685	B006	Lead (Pb)	178.00	MG/KG	NA	NA
685	B006	Manganese (Mn)	209.00	MG/KG	0.0610	NA
685	B006	Vanadium (V)	43.10	MG/KG	0.0844	NA
				Total	1.3286	38.75
685	B007	Aluminum (Al)	23200.00	MG/KG	0.3181	NA
685	B007	Arsenic (As)	10.00	MG/KG	0.4571	26.12
685	B007	Benzo(a)pyrene Equiv.	297.96	µG/KG	NA	4.93
685	B007	Chromium (Cr)	45.00	MG/KG	0.1234	NA
685	B007	Copper (Cu)	93.30	MG/KG	0.0317	NA
685	B007	Lead (Pb)	167.00	MG/KG	NA	NA
685	B007	Manganese (Mn)	326.00	MG/KG	0.0951	NA
685	B007	Vanadium (V)	43.90	MG/KG	0.0860	NA
				Total	1.1114	31.05
685	B008	Aluminum (Al)	14000.00	MG/KG	0.1920	NA
685	B008	Arsenic (As)	9.60	MG/KG	0.4388	25.08
685	B008	Benzo(a)pyrene Equiv.	148.64	µG/KG	NA	2.46
685	B008	Chromium (Cr)	44.40	MG/KG	0.1218	NA
685	B008	Copper (Cu)	494.00	MG/KG	0.1680	NA
685	B008	Lead (Pb)	459.00	MG/KG	NA	NA
685	B008	Manganese (Mn)	243.00	MG/KG	0.0709	NA
685	B008	Vanadium (V)	30.70	MG/KG	0.0601	NA
				Total	1.0515	27.54
685	B009	Aluminum (Al)	14600.00	MG/KG	0.2002	NA
685	B009	Antimony (Sb)	21.40	MG/KG	0.7336	NA
685	B009	Arsenic (As)	7.10	MG/KG	0.3245	18.55
685	B009	Benzo(a)pyrene Equiv.	277.09	µG/KG	NA	4.59
685	B009	Chromium (Cr)	78.00	MG/KG	0.2139	NA
685	B009	Copper (Cu)	483.00	MG/KG	0.1642	NA
685	B009	Lead (Pb)	949.00	MG/KG	NA	NA
685	B009	Manganese (Mn)	130.00	MG/KG	0.0379	NA
685	B009	Vanadium (V)	29.90	MG/KG	0.0586	NA
				Total	1.7330	23.13
685	B010	Aluminum (Al)	12400.00	MG/KG	0.1700	NA
685	B010	Antimony (Sb)	1.00	MG/KG	0.0343	NA
685	B010	Arsenic (As)	10.90	MG/KG	0.4982	28.47
685	B010	Benzo(a)pyrene Equiv.	177.35	µG/KG	NA	2.94
685	B010	Chromium (Cr)	32.40	MG/KG	0.0889	NA
685	B010	Copper (Cu)	102.00	MG/KG	0.0347	NA

Table 10.7.17
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
AOC 685
Charleston Naval Complex
Charleston, South Carolina

AOC	Location	Parameter	Concentration	Units	Hazard Index	Risk (E-06)
685	B010	Lead (Pb)	105.00	MG/KG	NA	NA
685	B010	Manganese (Mn)	274.00	MG/KG	0.0799	NA
				Total	0.9060	31.41
685	B011	Aluminum (Al)	10900.00	MG/KG	0.1495	NA
685	B011	Antimony (Sb)	0.88	MG/KG	0.0302	NA
685	B011	Arsenic (As)	6.80	MG/KG	0.3108	17.76
685	B011	Benzo(a)pyrene Equiv.	90.08	µG/KG	NA	1.49
685	B011	Chromium (Cr)	58.40	MG/KG	0.1602	NA
685	B011	Copper (Cu)	60.00	MG/KG	0.0204	NA
685	B011	Lead (Pb)	88.20	MG/KG	NA	NA
685	B011	Manganese (Mn)	180.00	MG/KG	0.0525	NA
				Total	0.7235	19.25
685	B012	Aluminum (Al)	10300.00	MG/KG	0.1412	NA
685	B012	Antimony (Sb)	0.94	MG/KG	0.0322	NA
685	B012	Arsenic (As)	5.50	MG/KG	0.2514	14.37
685	B012	Benzo(a)pyrene Equiv.	132.42	µG/KG	NA	2.19
685	B012	Chromium (Cr)	83.50	MG/KG	0.2290	NA
685	B012	Copper (Cu)	172.00	MG/KG	0.0585	NA
685	B012	Lead (Pb)	158.00	MG/KG	NA	NA
685	B012	Manganese (Mn)	178.00	MG/KG	0.0519	NA
				Total	0.7643	16.56
685	B013	Aluminum (Al)	13500.00	MG/KG	0.1851	NA
685	B013	Antimony (Sb)	0.60	MG/KG	0.0206	NA
685	B013	Arsenic (As)	7.80	MG/KG	0.3565	20.37
685	B013	Benzo(a)pyrene Equiv.	134.00	µG/KG	NA	2.22
685	B013	Chromium (Cr)	29.10	MG/KG	0.0798	NA
685	B013	Copper (Cu)	21.90	MG/KG	0.0074	NA
685	B013	Lead (Pb)	68.70	MG/KG	NA	NA
685	B013	Manganese (Mn)	218.00	MG/KG	0.0636	NA
				Total	0.7131	22.59
685	B014	Aluminum (Al)	13200.00	MG/KG	0.1810	NA
685	B014	Antimony (Sb)	0.44	MG/KG	0.0151	NA
685	B014	Arsenic (As)	5.90	MG/KG	0.2697	15.41
685	B014	Benzo(a)pyrene Equiv.	164.33	µG/KG	NA	2.72
685	B014	Chromium (Cr)	27.70	MG/KG	0.0760	NA
685	B014	Copper (Cu)	20.00	MG/KG	0.0068	NA
685	B014	Lead (Pb)	119.00	MG/KG	NA	NA
685	B014	Manganese (Mn)	167.00	MG/KG	0.0487	NA
				Total	0.5972	18.13
685	B015	Aluminum (Al)	17450.00	MG/KG	0.2393	NA
685	B015	Antimony (Sb)	0.78	MG/KG	0.0267	NA
685	B015	Arsenic (As)	7.25	MG/KG	0.3314	18.94
685	B015	Benzo(a)pyrene Equiv.	81.52	µG/KG	NA	1.35

Table 10.7.17
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Residential Scenario
AOC 685
Charleston Naval Complex
Charleston, South Carolina

AOC	Location	Parameter	Concentration	Units	Hazard Index	Risk (E-06)
685	B015	Chromium (Cr)	37.10	MG/KG	0.1017	NA
685	B015	Copper (Cu)	50.70	MG/KG	0.0172	NA
685	B015	Lead (Pb)	75.60	MG/KG	NA	NA
685	B015	Manganese (Mn)	356.00	MG/KG	0.1039	NA
				Total	0.8202	20.29
685	B016	Aluminum (Al)	16400.00	MG/KG	0.2249	NA
685	B016	Arsenic (As)	10.40	MG/KG	0.4754	27.16
685	B016	Chromium (Cr)	39.70	MG/KG	0.1089	NA
685	B016	Copper (Cu)	17.30	MG/KG	0.0059	NA
685	B016	Lead (Pb)	25.20	MG/KG	NA	NA
685	B016	Manganese (Mn)	908.00	MG/KG	0.2649	NA
685	B016	Vanadium (V)	43.90	MG/KG	0.0860	NA
				Total	1.1659	27.16
685	B017	Aluminum (Al)	28700.00	MG/KG	0.3935	NA
685	B017	Arsenic (As)	14.60	MG/KG	0.6673	38.14
685	B017	Benzo(a)pyrene Equiv.	263.15	µG/KG	NA	4.36
685	B017	Chromium (Cr)	53.00	MG/KG	0.1454	NA
685	B017	Copper (Cu)	57.50	MG/KG	0.0196	NA
685	B017	Lead (Pb)	332.00	MG/KG	NA	NA
685	B017	Manganese (Mn)	546.00	MG/KG	0.1593	NA
685	B017	Vanadium (V)	60.10	MG/KG	0.1177	NA
				Total	1.5028	42.49
685	B018	Aluminum (Al)	22500.00	MG/KG	0.3085	NA
685	B018	Arsenic (As)	13.10	MG/KG	0.5988	34.22
685	B018	Benzo(a)pyrene Equiv.	42.29	µG/KG	NA	0.70
685	B018	Chromium (Cr)	43.20	MG/KG	0.1185	NA
685	B018	Copper (Cu)	26.30	MG/KG	0.0089	NA
685	B018	Lead (Pb)	58.30	MG/KG	NA	NA
685	B018	Manganese (Mn)	465.00	MG/KG	0.1356	NA
685	B018	Vanadium (V)	51.70	MG/KG	0.1013	NA
				Total	1.2716	34.92
685	B019	Aluminum (Al)	8350.00	MG/KG	0.1145	NA
685	B019	Arsenic (As)	5.50	MG/KG	0.2514	14.37
685	B019	Benzo(a)pyrene Equiv.	68.86	µG/KG	NA	1.14
685	B019	Chromium (Cr)	16.50	MG/KG	0.0453	NA
685	B019	Copper (Cu)	13.80	MG/KG	0.0047	NA
685	B019	Lead (Pb)	20.90	MG/KG	NA	NA
685	B019	Manganese (Mn)	241.00	MG/KG	0.0703	NA
685	B019	Vanadium (V)	18.70	MG/KG	0.0366	NA
				Total	0.5228	15.51
685	B020	Aluminum (Al)	24200.00	MG/KG	0.3318	NA
685	B020	Arsenic (As)	10.10	MG/KG	0.4616	26.38
685	B020	Chromium (Cr)	49.90	MG/KG	0.1368	NA

Table 10.7.17
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
AOC 685
Charleston Naval Complex
Charleston, South Carolina

AOC	Location	Parameter	Concentration	Units	Hazard Index	Risk (E-06)
685	B020	Copper (Cu)	20.00	MG/KG	0.0068	NA
685	B020	Lead (Pb)	27.30	MG/KG	NA	NA
685	B020	Manganese (Mn)	1010.00	MG/KG	0.2946	NA
685	B020	Vanadium (V)	52.50	MG/KG	0.1028	NA
				Total	1.3346	26.38
685	B021	Aluminum (Al)	25700.00	MG/KG	0.3524	NA
685	B021	Arsenic (As)	14.00	MG/KG	0.6399	36.57
685	B021	Benzo(a)pyrene Equiv.	201.75	µG/KG	NA	3.34
685	B021	Chromium (Cr)	50.00	MG/KG	0.1371	NA
685	B021	Copper (Cu)	59.60	MG/KG	0.0203	NA
685	B021	Lead (Pb)	168.00	MG/KG	NA	NA
685	B021	Manganese (Mn)	440.00	MG/KG	0.1284	NA
685	B021	Vanadium (V)	58.10	MG/KG	0.1138	NA
				Total	1.3919	39.91
685	B022	Aluminum (Al)	23900.00	MG/KG	0.3277	NA
685	B022	Arsenic (As)	18.50	MG/KG	0.8456	48.32
685	B022	Chromium (Cr)	46.70	MG/KG	0.1281	NA
685	B022	Copper (Cu)	23.20	MG/KG	0.0079	NA
685	B022	Lead (Pb)	30.20	MG/KG	NA	NA
685	B022	Manganese (Mn)	751.00	MG/KG	0.2191	NA
685	B022	Vanadium (V)	63.10	MG/KG	0.1236	NA
				Total	1.6520	48.32
685	B023	Aluminum (Al)	15000.00	MG/KG	0.2057	NA
685	B023	Arsenic (As)	12.90	MG/KG	0.5896	33.69
685	B023	Benzo(a)pyrene Equiv.	2.92	µG/KG	NA	0.05
685	B023	Chromium (Cr)	34.10	MG/KG	0.0935	NA
685	B023	Copper (Cu)	14.60	MG/KG	0.0050	NA
685	B023	Lead (Pb)	19.50	MG/KG	NA	NA
685	B023	Manganese (Mn)	1050.00	MG/KG	0.3063	NA
685	B023	Vanadium (V)	37.00	MG/KG	0.0725	NA
				Total	1.2726	33.74
685	B024	Aluminum (Al)	19600.00	MG/KG	0.2688	NA
685	B024	Arsenic (As)	10.40	MG/KG	0.4754	27.16
685	B024	Chromium (Cr)	53.50	MG/KG	0.1467	NA
685	B024	Copper (Cu)	356.00	MG/KG	0.1210	NA
685	B024	Lead (Pb)	602.00	MG/KG	NA	NA
685	B024	Manganese (Mn)	505.00	MG/KG	0.1473	NA
685	B024	Vanadium (V)	45.40	MG/KG	0.0889	NA
				Total	1.2481	27.16
685	B025	Aluminum (Al)	17300.00	MG/KG	0.2372	NA
685	B025	Arsenic (As)	11.80	MG/KG	0.5394	30.82
685	B025	Benzo(a)pyrene Equiv.	3746.20	µG/KG	NA	62.04
685	B025	Chromium (Cr)	42.40	MG/KG	0.1163	NA

Table 10.7.17
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
AOC 685
Charleston Naval Complex
Charleston, South Carolina

AOC	Location	Parameter	Concentration	Units	Hazard Index	Risk (E-06)
685	B025	Copper (Cu)	95.20	MG/KG	0.0324	NA
685	B025	Lead (Pb)	93.50	MG/KG	NA	NA
685	B025	Manganese (Mn)	363.00	MG/KG	0.1059	NA
685	B025	Vanadium (V)	45.50	MG/KG	0.0891	NA
				Total	1.1202	92.86
685	B026	Aluminum (Al)	25100.00	MG/KG	0.3442	NA
685	B026	Arsenic (As)	20.70	MG/KG	0.9462	54.07
685	B026	Chromium (Cr)	50.50	MG/KG	0.1385	NA
685	B026	Copper (Cu)	24.10	MG/KG	0.0082	NA
685	B026	Lead (Pb)	29.90	MG/KG	NA	NA
685	B026	Manganese (Mn)	1660.00	MG/KG	0.4842	NA
685	B026	Vanadium (V)	61.00	MG/KG	0.1195	NA
				Total	2.0408	54.07
685	B027	Aluminum (Al)	13900.00	MG/KG	0.1906	NA
685	B027	Arsenic (As)	9.10	MG/KG	0.4159	23.77
685	B027	Benzo(a)pyrene Equiv.	72.37	µG/KG	NA	1.20
685	B027	Chromium (Cr)	34.90	MG/KG	0.0957	NA
685	B027	Copper (Cu)	94.70	MG/KG	0.0322	NA
685	B027	Lead (Pb)	196.00	MG/KG	NA	NA
685	B027	Manganese (Mn)	254.00	MG/KG	0.0741	NA
685	B027	Vanadium (V)	32.90	MG/KG	0.0644	NA
				Total	0.8730	24.97
685	B028	Aluminum (Al)	10900.00	MG/KG	0.1495	NA
685	B028	Arsenic (As)	10.30	MG/KG	0.4708	26.90
685	B028	Benzo(a)pyrene Equiv.	175.25	µG/KG	NA	2.90
685	B028	Chromium (Cr)	30.50	MG/KG	0.0836	NA
685	B028	Copper (Cu)	308.00	MG/KG	0.1047	NA
685	B028	Lead (Pb)	199.00	MG/KG	NA	NA
685	B028	Manganese (Mn)	231.00	MG/KG	0.0674	NA
685	B028	Vanadium (V)	32.10	MG/KG	0.0629	NA
				Total	0.9389	29.81
685	B029	Aluminum (Al)	24900.00	MG/KG	0.3414	NA
685	B029	Arsenic (As)	30.30	MG/KG	1.3849	79.14
685	B029	Chromium (Cr)	55.20	MG/KG	0.1514	NA
685	B029	Copper (Cu)	25.20	MG/KG	0.0086	NA
685	B029	Lead (Pb)	27.90	MG/KG	NA	NA
685	B029	Manganese (Mn)	1600.00	MG/KG	0.4667	NA
685	B029	Vanadium (V)	69.00	MG/KG	0.1352	NA
				Total	2.4882	79.14
685	B030	Aluminum (Al)	10800.00	MG/KG	0.1481	NA
685	B030	Antimony (Sb)	3.20	MG/KG	0.1097	NA
685	B030	Arsenic (As)	10.60	MG/KG	0.4845	27.69
685	B030	Benzo(a)pyrene Equiv.	137.76	µG/KG	NA	2.28

Table 10.7.17
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
AOC 685
Charleston Naval Complex
Charleston, South Carolina

AOC	Location	Parameter	Concentration	Units	Hazard Index	Risk (E-06)
685	B030	Chromium (Cr)	33.60	MG/KG	0.0921	NA
685	B030	Copper (Cu)	187.00	MG/KG	0.0636	NA
685	B030	Lead (Pb)	1110.00	MG/KG	NA	NA
685	B030	Manganese (Mn)	547.00	MG/KG	0.1596	NA
685	B030	Vanadium (V)	28.10	MG/KG	0.0550	NA
				Total	1.1126	29.97
685	B031	Aluminum (Al)	20700.00	MG/KG	0.2838	NA
685	B031	Arsenic (As)	15.10	MG/KG	0.6902	39.44
685	B031	Benzo(a)pyrene Equiv.	61.67	µG/KG	NA	1.02
685	B031	Chromium (Cr)	49.60	MG/KG	0.1360	NA
685	B031	Copper (Cu)	91.90	MG/KG	0.0312	NA
685	B031	Lead (Pb)	196.00	MG/KG	NA	NA
685	B031	Manganese (Mn)	1920.00	MG/KG	0.5601	NA
685	B031	Vanadium (V)	53.80	MG/KG	0.1054	NA
				Total	1.8068	40.46
685	B032	Aluminum (Al)	10700.00	MG/KG	0.1467	NA
685	B032	Arsenic (As)	12.10	MG/KG	0.5531	31.61
685	B032	Benzo(a)pyrene Equiv.	170.96	µG/KG	NA	2.83
685	B032	Chromium (Cr)	25.70	MG/KG	0.0705	NA
685	B032	Copper (Cu)	38.40	MG/KG	0.0131	NA
685	B032	Lead (Pb)	35.20	MG/KG	NA	NA
685	B032	Manganese (Mn)	711.00	MG/KG	0.2074	NA
685	B032	Vanadium (V)	42.70	MG/KG	0.0836	NA
				Total	1.0744	34.44
685	B033	Aluminum (Al)	29000.00	MG/KG	0.3977	NA
685	B033	Arsenic (As)	14.40	MG/KG	0.6582	37.61
685	B033	Chromium (Cr)	58.20	MG/KG	0.1596	NA
685	B033	Copper (Cu)	28.30	MG/KG	0.0096	NA
685	B033	Lead (Pb)	28.60	MG/KG	NA	NA
685	B033	Manganese (Mn)	493.00	MG/KG	0.1438	NA
685	B033	Vanadium (V)	74.50	MG/KG	0.1459	NA
				Total	1.5148	37.61
685	B034	Aluminum (Al)	15900.00	MG/KG	0.2180	NA
685	B034	Arsenic (As)	14.40	MG/KG	0.6582	37.61
685	B034	Chromium (Cr)	35.30	MG/KG	0.0968	NA
685	B034	Copper (Cu)	281.00	MG/KG	0.0955	NA
685	B034	Lead (Pb)	192.00	MG/KG	NA	NA
685	B034	Manganese (Mn)	370.00	MG/KG	0.1079	NA
685	B034	Vanadium (V)	32.50	MG/KG	0.0637	NA
				Total	1.2402	37.61
685	B035	Aluminum (Al)	19700.00	MG/KG	0.2701	NA
685	B035	Arsenic (As)	12.40	MG/KG	0.5668	32.39
685	B035	Chromium (Cr)	47.50	MG/KG	0.1303	NA

Table 10.7.17
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
AOC 685
Charleston Naval Complex
Charleston, South Carolina

AOC	Location	Parameter	Concentration	Units	Hazard Index	Risk (E-06)
685	B035	Copper (Cu)	195.00	MG/KG	0.0663	NA
685	B035	Lead (Pb)	180.00	MG/KG	NA	NA
685	B035	Manganese (Mn)	494.00	MG/KG	0.1441	NA
685	B035	Vanadium (V)	44.70	MG/KG	0.0876	NA
				Total	1.2651	32.39
685	B036	Aluminum (Al)	10050.00	MG/KG	0.1378	NA
685	B036	Arsenic (As)	8.90	MG/KG	0.4068	23.25
685	B036	Benzo(a)pyrene Equiv.	149.57	µG/KG	NA	2.48
685	B036	Chromium (Cr)	20.80	MG/KG	0.0570	NA
685	B036	Copper (Cu)	30.35	MG/KG	0.0103	NA
685	B036	Lead (Pb)	35.70	MG/KG	NA	NA
685	B036	Manganese (Mn)	811.00	MG/KG	0.2366	NA
685	B036	Vanadium (V)	27.55	MG/KG	0.0540	NA
				Total	0.9025	25.72

LEGEND

- NO COPCs
- < 1E-6
- 1E-6 to 5E-6
- 5E-6 to 1E-5
- 1E-5 to 1E-4
- > 1E-4

40 0 40 80 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.7.14
ZONE I
AOC 685

SURFACE SOIL POINT RISK
INDUSTRIAL SCENARIO

Table 10.7.18
Point Estimates of Risk and Hazard - Surface Soil Pathways
Industrial Scenario
AOC 685
Charleston Naval Complex
Charleston, South Carolina

AOC	Location	Parameter	Concentration	Units	Hazard Index	Risk (E-06)
685	B001	Aluminum (Al)	15300.00	MG/KG	0.0106	NA
685	B001	Arsenic (As)	20.7	MG/KG	0.0476	7.65
685	B001	Chromium (Cr)	51.6	MG/KG	0.0071	NA
685	B001	Copper (Cu)	13.4	MG/KG	0.0002	NA
685	B001	Lead (Pb)	24.3	MG/KG	NA	NA
685	B001	Manganese (Mn)	150	MG/KG	0.0022	NA
685	B001	Thallium (Tl)	0.71	MG/KG	0.0061	NA
685	B001	Vanadium (V)	34.0	MG/KG	0.0034	NA
				Total	0.0772	7.65
685	B002	Aluminum (Al)	23500	MG/KG	0.0162	NA
685	B002	Antimony (Sb)	6.1	MG/KG	0.0105	NA
685	B002	Arsenic (As)	11.8	MG/KG	0.0271	4.36
685	B002	Chromium (Cr)	47.9	MG/KG	0.0066	NA
685	B002	Copper (Cu)	24.1	MG/KG	0.0004	NA
685	B002	Lead (Pb)	29.4	MG/KG	NA	NA
685	B002	Manganese (Mn)	276	MG/KG	0.0041	NA
685	B002	Vanadium (V)	42.6	MG/KG	0.0042	NA
				Total	0.0691	4.36
685	B003	Aluminum (Al)	29900	MG/KG	0.0206	NA
685	B003	Arsenic (As)	15.5	MG/KG	0.0356	5.73
685	B003	Chromium (Cr)	56.8	MG/KG	0.0078	NA
685	B003	Copper (Cu)	22	MG/KG	0.0004	NA
685	B003	Lead (Pb)	36.7	MG/KG	NA	NA
685	B003	Manganese (Mn)	222	MG/KG	0.0033	NA
685	B003	Vanadium (V)	55.5	MG/KG	0.0055	NA
				Total	0.0732	5.73
685	B004	Aluminum (Al)	20900	MG/KG	0.0144	NA
685	B004	Arsenic (As)	9.2	MG/KG	0.0212	3.40
685	B004	Benzo(a)pyrene Equiv.	23	µG/KG	NA	0.08
685	B004	Chromium (Cr)	48.4	MG/KG	0.0067	NA
685	B004	Copper (Cu)	137	MG/KG	0.0023	NA
685	B004	Lead (Pb)	63.2	MG/KG	NA	NA
685	B004	Manganese (Mn)	217.5	MG/KG	0.0032	NA
685	B004	Vanadium (V)	43.4	MG/KG	0.0043	NA
				Total	0.0521	3.48
685	B005	Aluminum (Al)	12400	MG/KG	0.0086	NA
685	B005	Arsenic (As)	6.2	MG/KG	0.0143	2.29
685	B005	Benzo(a)pyrene Equiv.	59.36	µG/KG	NA	0.20
685	B005	Chromium (Cr)	34.1	MG/KG	0.0047	NA
685	B005	Copper (Cu)	464	MG/KG	0.0079	NA
685	B005	Lead (Pb)	306	MG/KG	NA	NA
685	B005	Manganese (Mn)	128	MG/KG	0.0019	NA
685	B005	Vanadium (V)	25.3	MG/KG	0.0025	NA
				Total	0.0398	2.49

Table 10.7.18
Point Estimates of Risk and Hazard - Surface Soil Pathways
Industrial Scenario
AOC 685
Charleston Naval Complex
Charleston, South Carolina

AOC	Location	Parameter	Concentration	Units	Hazard Index	Risk (E-06)
685	B006	Aluminum (Al)	22000	MG/KG	0.0152	NA
685	B006	Arsenic (As)	14.8	MG/KG	0.0340	5.47
685	B006	Benzo(a)pyrene Equiv.	5.46	µG/KG	NA	0.02
685	B006	Chromium (Cr)	47	MG/KG	0.0065	NA
685	B006	Copper (Cu)	224	MG/KG	0.0038	NA
685	B006	Lead (Pb)	178	MG/KG	NA	NA
685	B006	Manganese (Mn)	209	MG/KG	0.0031	NA
685	B006	Vanadium (V)	43.1	MG/KG	0.0042	NA
				Total	0.0668	5.49
685	B007	Aluminum (Al)	23200	MG/KG	0.0160	NA
685	B007	Arsenic (As)	10	MG/KG	0.0230	3.70
685	B007	Benzo(a)pyrene Equiv.	297.96	µG/KG	NA	1.00
685	B007	Chromium (Cr)	45	MG/KG	0.0062	NA
685	B007	Copper (Cu)	93.3	MG/KG	0.0016	NA
685	B007	Lead (Pb)	167	MG/KG	NA	NA
685	B007	Manganese (Mn)	326	MG/KG	0.0048	NA
685	B007	Vanadium (V)	43.9	MG/KG	0.0043	NA
				Total	0.0559	4.70
685	B008	Aluminum (Al)	14000	MG/KG	0.0097	NA
685	B008	Arsenic (As)	9.6	MG/KG	0.0221	3.55
685	B008	Benzo(a)pyrene Equiv.	148.64	µG/KG	NA	0.50
685	B008	Chromium (Cr)	44.4	MG/KG	0.0061	NA
685	B008	Copper (Cu)	494	MG/KG	0.0084	NA
685	B008	Lead (Pb)	459	MG/KG	NA	NA
685	B008	Manganese (Mn)	243	MG/KG	0.0036	NA
685	B008	Vanadium (V)	30.7	MG/KG	0.0030	NA
				Total	0.0529	4.05
685	B009	Aluminum (Al)	14600	MG/KG	0.0101	NA
685	B009	Antimony (Sb)	21.4	MG/KG	0.0369	NA
685	B009	Arsenic (As)	7.1	MG/KG	0.0163	2.62
685	B009	Benzo(a)pyrene Equiv.	277.09	µG/KG	NA	0.93
685	B009	Chromium (Cr)	78	MG/KG	0.0108	NA
685	B009	Copper (Cu)	483	MG/KG	0.0083	NA
685	B009	Lead (Pb)	949	MG/KG	NA	NA
685	B009	Manganese (Mn)	130	MG/KG	0.0019	NA
685	B009	Vanadium (V)	29.9	MG/KG	0.0029	NA
				Total	0.0872	3.56
685	B010	Aluminum (Al)	12400	MG/KG	0.0086	NA
685	B010	Antimony (Sb)	1	MG/KG	0.0017	NA
685	B010	Arsenic (As)	10.9	MG/KG	0.0251	4.03
685	B010	Benzo(a)pyrene Equiv.	177.35	µG/KG	NA	0.60
685	B010	Chromium (Cr)	32.4	MG/KG	0.0045	NA
685	B010	Copper (Cu)	102	MG/KG	0.0017	NA

Table 10.7.18
Point Estimates of Risk and Hazard - Surface Soil Pathways
Industrial Scenario
AOC 685
Charleston Naval Complex
Charleston, South Carolina

AOC	Location	Parameter	Concentration	Units	Hazard Index	Risk (E-06)
685	B010	Lead (Pb)	105	MG/KG	NA	NA
685	B010	Manganese (Mn)	274	MG/KG	0.0040	NA
				Total	0.0456	4.62
685	B011	Aluminum (Al)	10900	MG/KG	0.0075	NA
685	B011	Antimony (Sb)	0.88	MG/KG	0.0015	NA
685	B011	Arsenic (As)	6.8	MG/KG	0.0156	2.51
685	B011	Benzo(a)pyrene Equiv.	90.08	µG/KG	NA	0.30
685	B011	Chromium (Cr)	58.4	MG/KG	0.0081	NA
685	B011	Copper (Cu)	60	MG/KG	0.0010	NA
685	B011	Lead (Pb)	88.2	MG/KG	NA	NA
685	B011	Manganese (Mn)	180	MG/KG	0.0026	NA
				Total	0.0364	2.82
685	B012	Aluminum (Al)	10300	MG/KG	0.0071	NA
685	B012	Antimony (Sb)	0.94	MG/KG	0.0016	NA
685	B012	Arsenic (As)	5.5	MG/KG	0.0126	2.03
685	B012	Benzo(a)pyrene Equiv.	132.42	µG/KG	NA	0.45
685	B012	Chromium (Cr)	83.5	MG/KG	0.0115	NA
685	B012	Copper (Cu)	172	MG/KG	0.0029	NA
685	B012	Lead (Pb)	158	MG/KG	NA	NA
685	B012	Manganese (Mn)	178	MG/KG	0.0026	NA
				Total	0.0384	2.48
685	B013	Aluminum (Al)	13500	MG/KG	0.0093	NA
685	B013	Antimony (Sb)	0.6	MG/KG	0.0010	NA
685	B013	Arsenic (As)	7.8	MG/KG	0.0179	2.88
685	B013	Benzo(a)pyrene Equiv.	134	µG/KG	NA	0.45
685	B013	Chromium (Cr)	29.1	MG/KG	0.0040	NA
685	B013	Copper (Cu)	21.9	MG/KG	0.0004	NA
685	B013	Lead (Pb)	68.7	MG/KG	NA	NA
685	B013	Manganese (Mn)	218	MG/KG	0.0032	NA
				Total	0.0359	3.33
685	B014	Aluminum (Al)	13200	MG/KG	0.0091	NA
685	B014	Antimony (Sb)	0.44	MG/KG	0.0008	NA
685	B014	Arsenic (As)	5.9	MG/KG	0.0136	2.18
685	B014	Benzo(a)pyrene Equiv.	164.33	µG/KG	NA	0.55
685	B014	Chromium (Cr)	27.7	MG/KG	0.0038	NA
685	B014	Copper (Cu)	20	MG/KG	0.0003	NA
685	B014	Lead (Pb)	119	MG/KG	NA	NA
685	B014	Manganese (Mn)	167	MG/KG	0.0025	NA
				Total	0.0300	2.73
685	B015	Aluminum (Al)	17450	MG/KG	0.0120	NA
685	B015	Antimony (Sb)	0.78	MG/KG	0.0013	NA
685	B015	Arsenic (As)	7.25	MG/KG	0.0167	2.68
685	B015	Benzo(a)pyrene Equiv.	81.5	µG/KG	NA	0.27

Table 10.7.18
Point Estimates of Risk and Hazard - Surface Soil Pathways
Industrial Scenario
AOC 685
Charleston Naval Complex
Charleston, South Carolina

AOC	Location	Parameter	Concentration	Units	Hazard Index	Risk (E-06)
685	B015	Chromium (Cr)	37.1	MG/KG	0.0051	NA
685	B015	Copper (Cu)	50.7	MG/KG	0.0009	NA
685	B015	Lead (Pb)	75.60	MG/KG	NA	NA
685	B015	Manganese (Mn)	356	MG/KG	0.0052	NA
				Total	0.0413	2.95
685	B016	Aluminum (Al)	16400	MG/KG	0.0113	NA
685	B016	Arsenic (As)	10.4	MG/KG	0.0239	3.84
685	B016	Chromium (Cr)	39.7	MG/KG	0.0055	NA
685	B016	Copper (Cu)	17.3	MG/KG	0.0003	NA
685	B016	Lead (Pb)	25.2	MG/KG	NA	NA
685	B016	Manganese (Mn)	908	MG/KG	0.0133	NA
685	B016	Vanadium (V)	43.9	MG/KG	0.0043	NA
				Total	0.0586	3.84
685	B017	Aluminum (Al)	28700	MG/KG	0.0198	NA
685	B017	Arsenic (As)	14.6	MG/KG	0.0336	5.39
685	B017	Benzo(a)pyrene Equiv.	263.15	µG/KG	NA	0.89
685	B017	Chromium (Cr)	53.0	MG/KG	0.0073	NA
685	B017	Copper (Cu)	57.5	MG/KG	0.0010	NA
685	B017	Lead (Pb)	332	MG/KG	NA	NA
685	B017	Manganese (Mn)	546	MG/KG	0.0080	NA
685	B017	Vanadium (V)	60.1	MG/KG	0.0059	NA
				Total	0.0756	6.28
685	B018	Aluminum (Al)	22500	MG/KG	0.0155	NA
685	B018	Arsenic (As)	13.1	MG/KG	0.0301	4.84
685	B018	Benzo(a)pyrene Equiv.	42.29	µG/KG	NA	0.14
685	B018	Chromium (Cr)	43.2	MG/KG	0.0060	NA
685	B018	Copper (Cu)	26.3	MG/KG	0.0004	NA
685	B018	Lead (Pb)	58.3	MG/KG	NA	NA
685	B018	Manganese (Mn)	465	MG/KG	0.0068	NA
685	B018	Vanadium (V)	51.7	MG/KG	0.0051	NA
				Total	0.0640	4.98
685	B019	Aluminum (Al)	8350	MG/KG	0.0058	NA
685	B019	Arsenic (As)	5.5	MG/KG	0.0126	2.03
685	B019	Benzo(a)pyrene Equiv.	68.86	µG/KG	NA	0.23
685	B019	Chromium (Cr)	16.5	MG/KG	0.0023	NA
685	B019	Copper (Cu)	13.8	MG/KG	0.0002	NA
685	B019	Lead (Pb)	20.9	MG/KG	NA	NA
685	B019	Manganese (Mn)	241	MG/KG	0.0035	NA
685	B019	Vanadium (V)	18.7	MG/KG	0.0018	NA
				Total	0.0263	2.26
685	B020	Aluminum (Al)	24200	MG/KG	0.0167	NA
685	B020	Arsenic (As)	10.1	MG/KG	0.0232	3.73
685	B020	Chromium (Cr)	49.9	MG/KG	0.0069	NA

Table 10.7.18
Point Estimates of Risk and Hazard - Surface Soil Pathways
Industrial Scenario
AOC 685
Charleston Naval Complex
Charleston, South Carolina

AOC	Location	Parameter	Concentration	Units	Hazard Index	Risk (E-06)
685	B020	Copper (Cu)	20	MG/KG	0.0003	NA
685	B020	Lead (Pb)	27.3	MG/KG	NA	NA
685	B020	Manganese (Mn)	1010	MG/KG	0.0148	NA
685	B020	Vanadium (V)	52.5	MG/KG	0.0052	NA
				Total	0.0671	3.73
685	B021	Aluminum (Al)	25700	MG/KG	0.0177	NA
685	B021	Arsenic (As)	14.0	MG/KG	0.0322	5.17
685	B021	Benzo(a)pyrene Equiv.	201.75	µG/KG	NA	0.68
685	B021	Chromium (Cr)	50	MG/KG	0.0069	NA
685	B021	Copper (Cu)	59.6	MG/KG	0.0010	NA
685	B021	Lead (Pb)	168	MG/KG	NA	NA
685	B021	Manganese (Mn)	440	MG/KG	0.0065	NA
685	B021	Vanadium (V)	58.1	MG/KG	0.0057	NA
				Total	0.0700	5.85
685	B022	Aluminum (Al)	23900	MG/KG	0.0165	NA
685	B022	Arsenic (As)	18.5	MG/KG	0.0425	6.84
685	B022	Chromium (Cr)	46.7	MG/KG	0.0064	NA
685	B022	Copper (Cu)	23.2	MG/KG	0.0004	NA
685	B022	Lead (Pb)	30.2	MG/KG	NA	NA
685	B022	Manganese (Mn)	751	MG/KG	0.0110	NA
685	B022	Vanadium (V)	63.1	MG/KG	0.0062	NA
				Total	0.0831	6.84
685	B023	Aluminum (Al)	15000	MG/KG	0.0103	NA
685	B023	Arsenic (As)	12.9	MG/KG	0.0297	4.77
685	B023	Benzo(a)pyrene Equiv.	2.92	µG/KG	NA	0.01
685	B023	Chromium (Cr)	34.1	MG/KG	0.0047	NA
685	B023	Copper (Cu)	14.6	MG/KG	0.0002	NA
685	B023	Lead (Pb)	19.5	MG/KG	NA	NA
685	B023	Manganese (Mn)	1050	MG/KG	0.0154	NA
685	B023	Vanadium (V)	37.0	MG/KG	0.0036	NA
				Total	0.0640	4.78
685	B024	Aluminum (Al)	19600	MG/KG	0.0135	NA
685	B024	Arsenic (As)	10.4	MG/KG	0.0239	3.84
685	B024	Chromium (Cr)	53.5	MG/KG	0.0074	NA
685	B024	Copper (Cu)	356	MG/KG	0.0061	NA
685	B024	Lead (Pb)	602	MG/KG	NA	NA
685	B024	Manganese (Mn)	505	MG/KG	0.0074	NA
685	B024	Vanadium (V)	45.4	MG/KG	0.0045	NA
				Total	0.0628	3.84
685	B025	Aluminum (Al)	17300	MG/KG	0.0119	NA
685	B025	Arsenic (As)	11.8	MG/KG	0.0271	4.36
685	B025	Benzo(a)pyrene Equiv.	3746.2	µG/KG	NA	12.61
685	B025	Chromium (Cr)	42.4	MG/KG	0.0058	NA

Table 10.7.18
Point Estimates of Risk and Hazard - Surface Soil Pathways
Industrial Scenario
AOC 685
Charleston Naval Complex
Charleston, South Carolina

AOC	Location	Parameter	Concentration	Units	Hazard Index	Risk (E-06)
685	B025	Copper (Cu)	95.2	MG/KG	0.0016	NA
685	B025	Lead (Pb)	93.5	MG/KG	NA	NA
685	B025	Manganese (Mn)	363	MG/KG	0.0053	NA
685	B025	Vanadium (V)	45.5	MG/KG	0.0045	NA
				Total	0.0564	16.97
685	B026	Aluminum (Al)	25100	MG/KG	0.0173	NA
685	B026	Arsenic (As)	20.7	MG/KG	0.0476	7.65
685	B026	Chromium (Cr)	50.5	MG/KG	0.0070	NA
685	B026	Copper (Cu)	24.1	MG/KG	0.0004	NA
685	B026	Lead (Pb)	29.9	MG/KG	NA	NA
685	B026	Manganese (Mn)	1660	MG/KG	0.0244	NA
685	B026	Vanadium (V)	61	MG/KG	0.0060	NA
				Total	0.1027	7.65
685	B027	Aluminum (Al)	13900	MG/KG	0.0096	NA
685	B027	Arsenic (As)	9.1	MG/KG	0.0209	3.36
685	B027	Benzo(a)pyrene Equiv.	72.37	μG/KG	NA	0.24
685	B027	Chromium (Cr)	34.9	MG/KG	0.0048	NA
685	B027	Copper (Cu)	94.7	MG/KG	0.0016	NA
685	B027	Lead (Pb)	196	MG/KG	NA	NA
685	B027	Manganese (Mn)	254	MG/KG	0.0037	NA
685	B027	Vanadium (V)	32.9	MG/KG	0.0032	NA
				Total	0.0439	3.61
685	B028	Aluminum (Al)	10900	MG/KG	0.0075	NA
685	B028	Arsenic (As)	10.3	MG/KG	0.0237	3.81
685	B028	Benzo(a)pyrene Equiv.	175.25	μG/KG	NA	0.59
685	B028	Chromium (Cr)	30.5	MG/KG	0.0042	NA
685	B028	Copper (Cu)	308	MG/KG	0.0053	NA
685	B028	Lead (Pb)	199	MG/KG	NA	NA
685	B028	Manganese (Mn)	231	MG/KG	0.0034	NA
685	B028	Vanadium (V)	32.1	MG/KG	0.0032	NA
				Total	0.0472	4.40
685	B029	Aluminum (Al)	24900	MG/KG	0.0172	NA
685	B029	Arsenic (As)	30.3	MG/KG	0.0697	11.20
685	B029	Chromium (Cr)	55.2	MG/KG	0.0076	NA
685	B029	Copper (Cu)	25.2	MG/KG	0.0004	NA
685	B029	Lead (Pb)	27.9	MG/KG	NA	NA
685	B029	Manganese (Mn)	1600	MG/KG	0.0235	NA
685	B029	Vanadium (V)	69	MG/KG	0.0068	NA
				Total	0.1252	11.20
685	B030	Aluminum (Al)	10800	MG/KG	0.0074	NA
685	B030	Antimony (Sb)	3.2	MG/KG	0.0055	NA
685	B030	Arsenic (As)	10.6	MG/KG	0.0244	3.92
685	B030	Benzo(a)pyrene Equiv.	137.76	μG/KG	NA	0.46

Table 10.7.18
Point Estimates of Risk and Hazard - Surface Soil Pathways
Industrial Scenario
AOC 685
Charleston Naval Complex
Charleston, South Carolina

AOC	Location	Parameter	Concentration	Units	Hazard Index	Risk (E-06)
685	B030	Chromium (Cr)	33.6	MG/KG	0.0046	NA
685	B030	Copper (Cu)	187	MG/KG	0.0032	NA
685	B030	Lead (Pb)	1110	MG/KG	NA	NA
685	B030	Manganese (Mn)	547	MG/KG	0.0080	NA
685	B030	Vanadium (V)	28.1	MG/KG	0.0028	NA
				Total	0.0560	4.38
685	B031	Aluminum (Al)	20700	MG/KG	0.0143	NA
685	B031	Arsenic (As)	15.1	MG/KG	0.0347	5.58
685	B031	Benzo(a)pyrene Equiv.	61.67	µG/KG	NA	0.21
685	B031	Chromium (Cr)	49.6	MG/KG	0.0068	NA
685	B031	Copper (Cu)	91.9	MG/KG	0.0016	NA
685	B031	Lead (Pb)	196	MG/KG	NA	NA
685	B031	Manganese (Mn)	1920	MG/KG	0.0282	NA
685	B031	Vanadium (V)	53.8	MG/KG	0.0053	NA
				Total	0.0909	5.79
685	B032	Aluminum (Al)	10700	MG/KG	0.0074	NA
685	B032	Arsenic (As)	12.1	MG/KG	0.0278	4.47
685	B032	Benzo(a)pyrene Equiv.	170.96	µG/KG	NA	0.58
685	B032	Chromium (Cr)	25.7	MG/KG	0.0035	NA
685	B032	Copper (Cu)	38.4	MG/KG	0.0007	NA
685	B032	Lead (Pb)	35.2	MG/KG	NA	NA
685	B032	Manganese (Mn)	711	MG/KG	0.0104	NA
685	B032	Vanadium (V)	42.7	MG/KG	0.0042	NA
				Total	0.0540	5.05
685	B033	Aluminum (Al)	29000	MG/KG	0.0200	NA
685	B033	Arsenic (As)	14.4	MG/KG	0.0331	5.32
685	B033	Chromium (Cr)	58.2	MG/KG	0.0080	NA
685	B033	Copper (Cu)	28.3	MG/KG	0.0005	NA
685	B033	Lead (Pb)	28.6	MG/KG	NA	NA
685	B033	Manganese (Mn)	493	MG/KG	0.0072	NA
685	B033	Vanadium (V)	74.5	MG/KG	0.0073	NA
				Total	0.0762	5.32
685	B034	Aluminum (Al)	15900	MG/KG	0.0110	NA
685	B034	Arsenic (As)	14.4	MG/KG	0.0331	5.32
685	B034	Chromium (Cr)	35.3	MG/KG	0.0049	NA
685	B034	Copper (Cu)	281	MG/KG	0.0048	NA
685	B034	Lead (Pb)	192	MG/KG	NA	NA
685	B034	Manganese (Mn)	370	MG/KG	0.0054	NA
685	B034	Vanadium (V)	32.50	MG/KG	0.0032	NA
				Total	0.0624	5.32
685	B035	Aluminum (Al)	19700	MG/KG	0.0136	NA
685	B035	Arsenic (As)	12.4	MG/KG	0.0285	4.58
685	B035	Chromium (Cr)	47.5	MG/KG	0.0066	NA

Table 10.7.18
Point Estimates of Risk and Hazard - Surface Soil Pathways
Industrial Scenario
AOC 685
Charleston Naval Complex
Charleston, South Carolina

AOC	Location	Parameter	Concentration	Units	Hazard Index	Risk (E-06)
685	B035	Copper (Cu)	195	MG/KG	0.0033	NA
685	B035	Lead (Pb)	180	MG/KG	NA	NA
685	B035	Manganese (Mn)	494	MG/KG	0.0072	NA
685	B035	Vanadium (V)	44.7	MG/KG	0.0044	NA
				Total	0.0636	4.58
685	B036	Aluminum (Al)	10050	MG/KG	0.0069	NA
685	B036	Arsenic (As)	8.9	MG/KG	0.0205	3.29
685	B036	Benzo(a)pyrene Equiv.	149.57	µG/KG	NA	0.50
685	B036	Chromium (Cr)	20.8	MG/KG	0.0029	NA
685	B036	Copper (Cu)	30.35	MG/KG	0.0005	NA
685	B036	Lead (Pb)	35.7	MG/KG	NA	NA
685	B036	Manganese (Mn)	811	MG/KG	0.0119	NA
685	B036	Vanadium (V)	27.55	MG/KG	0.0027	NA
				Total	0.0454	3.79

Table 10.7.19
Remedial Goal Options for Surface Soil
AOC 685
Charleston Naval Complex
Charleston, South Carolina

Residential-Based Remedial Goal Options

Chemical	Slope Factor $(mg/kg\text{-}day)^{-1}$	Reference Dose (mg/kg-day)	EPC mg/kg	Hazard-Based Remedial Goal Options **3** mg/kg	**1** mg/kg	**0.1** mg/kg	Risk-Based Remedial Goal Options **1E-06** mg/kg	**1E-05** mg/kg	**1E-04** mg/kg	Background Concentration mg/kg
Benzo(a)pyrene Equivalents	7.3	NA	0.67	ND	ND	ND	0.06	0.6	6	ND
Aluminum	NA	1	20090	218781	72927	7293	ND	ND	ND	27400
Arsenic	1.5	0.0003	13.4	66	22	2.2	0.38	3.8	38	21.6
Chromium	NA	0.005	49.2	1094	365	36	ND	ND	ND	34.5

Worker-Based Remedial Goal Options

Chemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	EPC mg/kg	Hazard-Based Remedial Goal Options **3** mg/kg	**1** mg/kg	**0.1** mg/kg	Risk-Based Remedial Goal Options **1E-06** mg/kg	**1E-05** mg/kg	**1E-04** mg/kg	Background Concentration mg/kg
Benzo(a)pyrene Equivalents	7.3	NA	0.67	ND	ND	ND	0.30	3.0	30	ND
Arsenic	1.5	0.0003	2.4	228	76	7.6	0.47	4.7	47	21.6

Notes:
EPC exposure point concentration
NA not applicable
ND not determined
- remedial goal options were calculated based on the resident lifetime-weighted average for carcinogens and on the child resident for noncarcinogens

BEQs, aluminum, arsenic, and chromium were identified as soil pathway COCs for AOC 685. Table 10.7.20 presents cumulative and COC-specific exposure risks and hazard quotients.

Risk-based remedial goals for surface soil are presented in Table 10.7.19. Potential corrective measures for soil are presented in Table 10.7.21.

Table 10.7.20
AOC 685
Cumulative and Chemical-Specific Exposure Risks and Hazard

	Risk		Hazard	
Chemical	**Industrial**	**Residential**	**Industrial**	**Residential**
Soil				
BEQs	2.26E-6	1.12E-5	ND	ND
Aluminum	ND	ND	0.014	0.28
Arsenic	4.9E-6	3.55E-5	0.031	0.61
Chromium	ND	ND	0.0068	0.14
Cumulative	7.16E-6	4.67E-5	0.0518	1.03

Note:
ND = Not detected

Table 10.7.21
AOC 685
Potential Corrective Measures

Medium	Compounds	Potential Corrective Measures
Soil	BEQs, Aluminum, Arsenic, Chromium	a) No action b) Excavation, offsite disposal, and monitoring c) Containment/capping

10.8 AOC 687 (Ammunition Storage Bunker), Building X-55, and SWMU 16 (Paint Storage Bunker)

AOC 687 consists of Building X-55, an earth covered ammunition storage bunker constructed in 1942. The concrete walls and ceiling of the bunker are 4 feet thick. The entire structure is covered by 2 feet of soil. Surrounding the bunker, is a cement and soil containment berm designed to control the bunker door in the event of an explosion. The storage bunker is approximately 29 feet wide, 52 feet long, and 12 feet high. The area is surrounded by a chain-link fence. The AOC is located between Juneau Avenue and the Dredged Materials Area (DMA). The Cooper River and associated wetlands are to the east of the site across Juneau Avenue.

The bunker appears to have been used for ammunition storage since its construction in 1942. No other uses are known. At the time of the RFA, explosives and small arms ammunition were stored in the bunker. The magazine is currently empty, although no information is available regarding the dates of explosive/ammunition removal.

SWMU 16 (the earthen roof of Building X-55) has been associated with AOC 687 due to prior unauthorized storage of potentially hazardous material (empty paint containers). This paint container storage was identified as a one time occurrence and is not thought to represent a historical problem. Minor spills associated with the storage of the paint containers were cleaned and the paint containers themselves were removed from the site at the time of discovery.

Materials of concern identified in the final RFI work plan include explosives, paint wastes, and paint thinner. Potential receptors include workers involved in invasive and noninvasive activities at these sites. The Cooper River and nearby wetlands are also potential ecological receptors.

To fulfill CSI objectives for AOC 687 and RFI objectives for SWMU 16, soil, sediment, and groundwater were sampled in accordance with the final RFI work plan and Section 3 of this report. Only four of 11 soil borings were advanced during field work. Borings proposed for SWMU 16 were not drilled because paint container storage was identified as a one time issue and not a long-term or historical problem.

Grid soil sample GDISB00801 was collected in the area of the combined sites and analyzed for the standard suite of parameters. No subsurface grid soil sample was collected at this location. Results of these analyses are discussed with the combined sites.

10.8.1 Soil Sampling and Analysis

Soil was sampled in one round at the combined sites from the locations shown in Figure 10.8.1. The final RFI work plan proposed 11 soil borings at the combined sites with samples collected from both the upper and lower-intervals. During the field investigation, soil samples were collected from the four monitoring well borings advanced around the combined sites' perimeter, as proposed in the work plan. Four upper-interval and two lower-interval samples were collected from these boring locations. Seven soil samples proposed for collection from the earthen roof of Building X-55 were deleted during the field investigation. Samples were submitted for the standard suite of parameters (VOCs, SVOCs, metals, cyanide, pesticides, and PCBs) and organotins at DQO Level III. One upper-interval duplicate sample was analyzed for the standard suite of parameters, plus organotins at DQO Level IV. Table 10.8.1 summarizes the soil sampling at the combined sites.

Grid-based soil boring (GDI008) was advanced in the area of the combined sites as shown in Figure 10.8.1. Upper-interval samples from this boring were analyzed for the standard suite of parameters. No lower-interval samples were collected from this boring. Results of sample analyses are presented in the nature and extent discussion of the combined sites and presented in Appendix D.

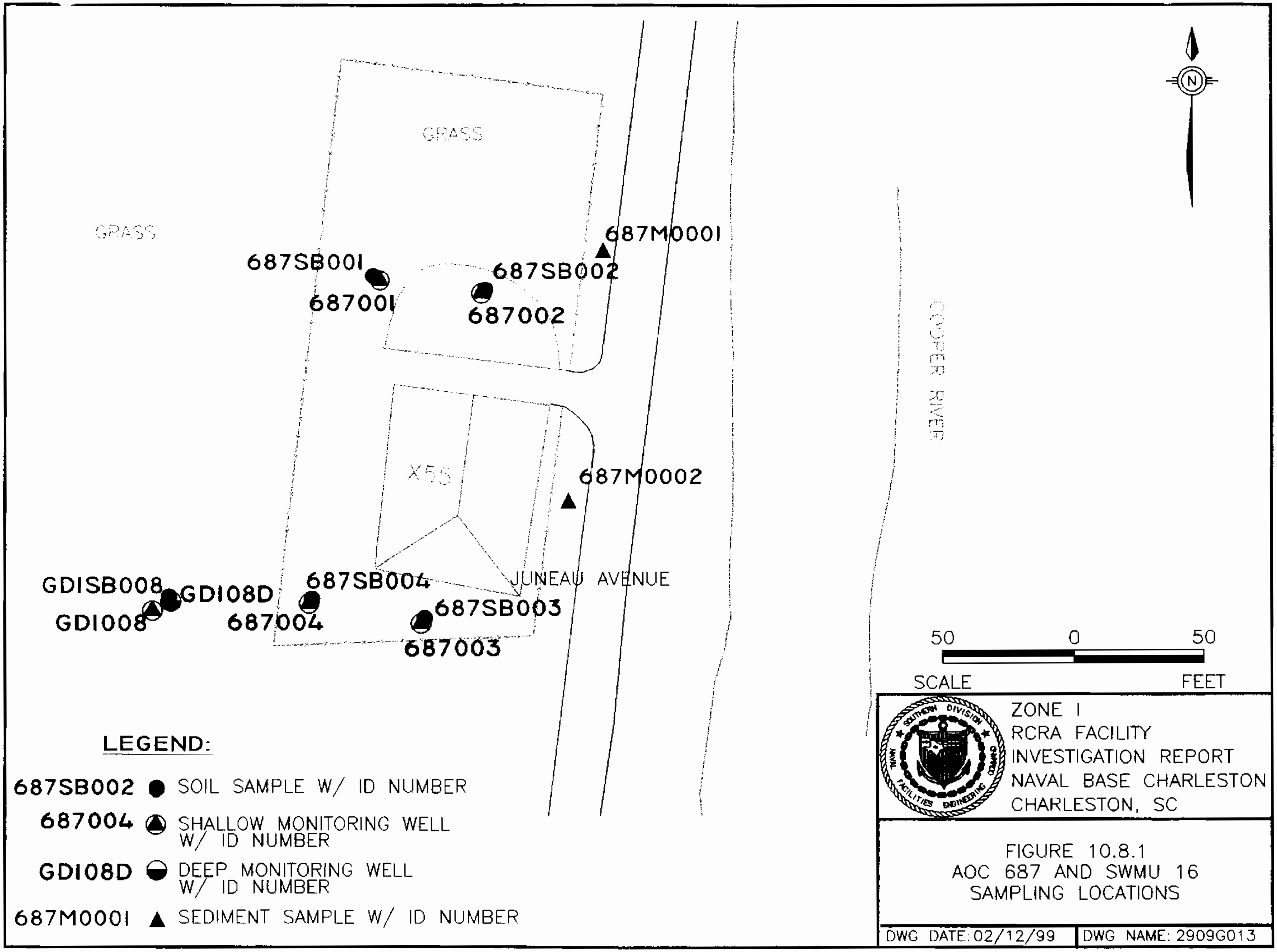


FIGURE 10.8.1
AOC 687 AND SWMU 16
SAMPLING LOCATIONS

Table 10.8.1
AOC 687 and SWMU 16
Soil Sampling Summary

Sampling Round	Sampling Date	Samples Collected	Sample Analyses	Comments
1	03/30/95 03/31/95	Upper - 4 (11)	Standard Suite, Organotins, Physical Parameters	
		Lower - 2 (11)	Standard Suite, Organotins	
		Duplicate - 1	Standard Suite, Organotins	

Notes:
( ) = Parentheses indicate number of samples proposed.
Standard Suite = VOCs, SVOCs, metals, cyanide, pesticides, and PCBs at DQO Level III.
Physical parameters analysis included CEC, chloride, sulfur, ammonia, nitrate/nitrite, phosphorus, TOC and total moisture.

10.8.2 Nature and Extent of Contamination in Soil

Organic compound analytical data for soil are summarized in Table 10.8.2. Table 10.8.3 summarizes inorganic analytical results. Table 10.8.4 summarizes all analytes detected in the soil at AOC 687/SWMU 16. Appendix D is a complete analytical report for all samples collected in Zone I.

Volatile Organic Compounds in Soil

Two VOCs - acetone and methylene chloride - were detected in surface soil samples at the combined sites. Of the two, only acetone was detected in subsurface soil at these sites. All surface and subsurface soil VOC concentrations were far below their RBCs and SSLs.

No VOCs were detected in surface soil at grid soil boring GDISB008.

Table 10.8.2
AOC 687 and SWMU 16
Organic Compound Analytical Results for Soil (μg/kg)

Parameters	Sample Interval	Detection Frequency	Detection Range	Mean	RBC (upper) SSL (lower)	Number of Samples Exceeding RBC or SSL
Volatile Organic Compounds						
Acetone	Upper	2/4	8.0 - 8.5	8.3	780,000	0
	Lower	1/2	22.0	22.0	8,000	0
Methylene chloride	Upper	1/4	28.0	28.0	85,000	0
	Lower	0/2	ND	ND	10.0	0
Pesticides/PCBs						
Methoxychlor	Upper	0/4	ND	ND	39,000	0
	Lower	1/2	8.6	8.6	80,000	0
beta-BHC	Upper	2/4	1.3 - 1.4	1.4	350	0
	Lower	1/2	2.5	2.5	1.3	1
Aroclor-1260	Upper	2/4	27.0 - 35.0	31.0	320	0
	Lower	0/2	ND	ND	1,000	0
Dioxin Compounds and Organotins						
Tetrabutyltin	Upper	0/4	ND	ND	2,300	0
	Lower	1/2	5.5	5.5	NL	0

Notes:
ND = Not Detected/Not Determined
NL = Not Listed
μg/kg = Micrograms per kilogram
See Table 5.5 for organic compound screening concentrations and their sources.

Table 10.8.3
AOC 687 and SWMU 16
Inorganic Analytical Results for Soil (mg/kg)

Parameters	Sample Interval	Detection Frequency	Detection Range	Mean	Background Concentration	RBC (upper) SSL (lower)	Number of Samples Exceeding: RBC and Background (upper) or SSL and Background (lower)
Aluminum (Al)	Upper	4/4	4,565 - 19,300	12,000	27,400	7,800	0
	Lower	2/2	27,700 - 27,900	27,800	18,900	560,000	0
Arsenic (As)	Upper	4/4	3.4 - 12.4	8.1	21.6	0.43	0
	Lower	2/2	17.2 - 19.8	18.5	6.45	15	2
Barium (Ba)	Upper	4/4	13.9 - 26.5	18.9	54.2	550	0
	Lower	2/2	32.5 - 33.9	33.2	36	820	0
Beryllium (Be)	Upper	3/4	0.45 - 0.89	0.67	0.95	16	0
	Lower	2/2	1.1 - 1.2	1.15	0.67	32	0
Calcium (Ca)	Upper	4/4	3,260 - 33,000	16,400	NL	NL	NA
	Lower	2/2	5,470 - 6,830	6,150	NL	NL	NA
Chromium (Cr)	Upper	4/4	10.6 - 40.0	27.3	34.5	39	1
	Lower	2/2	46.7 - 50.1	48.4	51.3	19	0
Cobalt (Co)	Upper	4/4	0.89 - 5.3	3.23	5.8	470	0
	Lower	2/2	5.9 - 7.4	6.65	3.48	990	0
Copper (Cu)	Upper	4/4	3.6 - 19.1	12.6	240	310	0
	Lower	2/2	21.1 - 25.8	23.5	11.5	5,600	0
Iron (Fe)	Upper	4/4	6,980 - 22,100	14,350	NL	NL	NA
	Lower	2/2	31,800 - 33,600	32,700	NL	NL	NA
Lead (Pb)	Upper	4/4	11.0 - 20.4	15.9	203	400	0
	Lower	2/2	22.9 - 27.5	25.2	12.3	400	0
Magnesium (Mg)	Upper	4/4	487 - 3,260	2,030	NL	NL	NA
	Lower	2/2	3,220 - 3,740	3,480	NL	NL	NA

Table 10.8.3
AOC 687 and SWMU 16
Inorganic Analytical Results for Soil (mg/kg)

Parameters	Sample Interval	Detection Frequency	Detection Range	Mean	Background Concentration	RBC (upper) SSL (lower)	Number of Samples Exceeding: RBC and Background (upper) or SSL and Background (lower)
Manganese (Mn)	Upper	4/4	49.8 - 482	263	419	160	1
	Lower	2/2	282 - 355	319	118	480	0
Mercury (Hg)	Upper	1/4	0.14	0.14	0.47	2.3	0
	Lower	0/2	ND	ND	ND	1.0	0
Nickel (Ni)	Upper	4/4	2.7 - 12.5	8.2	23.9	160	0
	Lower	2/2	12.4 - 13.8	13.1	15.7	65	0
Potassium (K)	Upper	4/4	343 - 1,780	1,170	NL	NL	NA
	Lower	2/2	1,800 - 1,930	1,870	NL	NL	NA
Selenium (Se)	Upper	4/4	0.76 - 1.5	1.1	1.49	39	0
	Lower	2/2	1.4 - 2.0	1.7	1.77	2.6	0
Sodium (Na)	Upper	1/4	364	364	NL	NL	NA
	Lower	2/2	715 - 881	798	NL	NL	NA
Vanadium (V)	Upper	4/4	15.9 - 42.6	27.7	113	55	0
	Lower	2/2	61.0 - 72.0	66.5	38.1	3,000	0
Zinc (Zn)	Upper	4/4	18.9 - 78.4	49.8	206	2,300	0
	Lower	2/2	72.5 - 76.7	74.6	36.2	6,200	0

Notes:
NA = Not Applicable/Not Available
ND = Not Detected/Not Determined
NL = Not Listed
mg/kg = Milligrams per kilogram
See Table 5.6 for inorganic element screening concentrations and their sources.

Table 10.8.4
AOC 687 and SWMU 16
Analytes Detected in Surface, Subsurface Soil, and Sediment

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Volatile Organic Compounds (μg/kg)							
Acetone	687SB003	8.5	780000	NA	22	8000	NA
	687SB004	8			NT		
Methylene chloride	687SB001	28	85000	NA	ND	10	NA
Semivolatile Organic Compounds (μg/kg)							
Acenaphthylene	687M0002	63	310000	NA	NT	96000	NA
Anthracene	687M0002	94.5	2300000	NA	NT	5900000	NA
Benzo(g,h,i)perylene	687M0002	405	310000	NA	NT	1.2e+08	NA
Benzo(a)pyrene Equivalents (BEQs)	687M0002	**1305**	87	NA	NT	1600	NA
Benzo(a)anthracene	687M0002	580	870	NA	NT	800	NA
Benzo(a)pyrene	687M0002	**790**	87	NA	NT	4000	NA
Benzo(b)fluoranthene	687M0002	**2650**	870	NA	NT	2500	NA
Benzo(k)fluoranthene	687M0002	2950	8700	NA	NT	25000	NA
Chrysene	687M0002	1650	87000	NA	NT	80000	NA
Dibenz(a,h)anthracene	687M0002	**120**	87	NA	NT	800	NA
Indeno(1,2,3-cd)pyrene	687M0002	405	870	NA	NT	7000	NA
bis(2-Ethylhexyl)phthalate	687M0001	180	46000	NA	NT	1800000	NA
(BEHP)	687M0002	250			NT		
Fluoranthene	687M0001	49	310000	NA	NT	2100000	NA
	687M0002	2100			NT		
1-Methylnaphthalene	687M0002	80	310000	NA	NT	72000	NA

Table 10.8.4
AOC 687 and SWMU 16
Analytes Detected in Surface, Subsurface Soil, and Sediment

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Phenanthrene	687M0002	225	230000	NA	NT	660000	NA
Pyrene	687M0001	38	230000	NA	NT	2100000	NA
	687M0002	1650			NT		
Pesticides/PCBs (μg/kg)							
Aldrin	687M0001	0.057	38	NA	NT	230	NA
	687M0002	1.25			NT		
Aroclor-1260	687SB001	35	320	NA	ND	1000	NA
	687SB004	27			NT		
beta-BHC (beta-HCH)	687SB001	1.3	350	NA	2.5	1.3	NA
	687SB004	1.4			NT		
	687M0002	3.35			NT		
delta-BHC (delta-HCH)	687M0001	0.83	350	NA	NT	1.8	NA
	687M0002	1.55			NT		
Chlordane	687M0002	5250	1800	NA	NT	5000	NA
4,4'-DDD	687M0002	20.5	2700	NA	NT	8000	NA
4,4'-DDE	687M0001	3.3	1900	NA	NT	27000	NA
	687M0002	128.5			NT		
4,4'-DDT	687M0001	1.1	1900	NA	NT	16000	NA
	687M0002	6.85			NT		
Dieldrin	687M0001	1.9	40	NA	NT	2	NA
	687M0002	2.04			NT		
Endosulfan I	687M0001	1.4	47000	NA	NT	9000	NA

Table 10.8.4
AOC 687 and SWMU 16
Analytes Detected in Surface, Subsurface Soil, and Sediment

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Endosulfan II	687M0001	0.96	47000	NA	NT	9000	NA
	687M0002	3			NT		
Endosulfan sulfate	687M0002	2.8	47000	NA	NT	4600	NA
Endrin	687M0001	0.96	2300	NA	NT	500	NA
	687N0002	8.4			NT		
Endrin aldehyde	687M0001	1.2	2300	NA	NT	340	NA
	687M0002	57			NT		
Heptachlor	687M0002	2.95	140	NA	NT	11000	NA
Heptachlor epoxide	687M0002	36.7	70	NA	NT	330	NA
Methoxychlor	687SB001	ND	39000	NA	8.6	80000	NA
	687M0001	2			NT		
	687M0002	8.7			NT		
Organophosphate Pesticides (μg/kg)							
Dimethoate	687N0002	36	1600	NA	NT	15	NA
Parathion	687N0002	9.6	47000	NA	NT	27000	NA
Herbicides (μg/kg)							
2,4,5-T	687N0002	7.8	78000	NA	NT	990	NA
2,4,5-TP (Silvex)	687N0002	120	63000	NA	NT	5600	NA
Organotin (μg/kg)							
Tetrabutyltin	687SB003	ND	2300	NA	5.5	NA	NA
Dioxin Compounds (ng/kg)							
2,3,7,8-TCDD equivalents (TEQs)	687M0002	0.118	4.3	NA	NT	1600	NA

Table 10.8.4
AOC 687 and SWMU 16
Analytes Detected in Surface, Subsurface Soil, and Sediment

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
1234678-HpCDD	687M0002	6.357	430	NA	NT	108000	NA
OCDD	687M0002	39.39	4300	NA	NT	1080000	NA
1234678-HpCDF	687M0002	1.251	430	NA	NT	54000	NA
OCDF	687M0002	2.655	4300	NA	NT	540000	NA
Inorganics (mg/kg)							
Aluminum (Al)	687SB001	9110	7800	27400	27900	560000	18900
	687SB002	15000			NT		
	687SB003	4565			27700		
	687SB004	19300			NT		
	687M0001	8420			NT		
	687M0002	14950			NT		
Antimony (Sb)	687M0001	0.58	3.1	ND	NT	2.7	ND
	687M0002	0.77			NT		
Arsenic (As)	687SB001	7	0.43	21.6	17.2	15	6.45
	687SB002	9.5			NT		
	687CB003	3.35			19.8		
	687SB004	12.4			NT		
	687M0001	6.9			NT		
	687M0002	11.85			NT		
Barium (Ba)	687SB001	15.4	550	54.2	32.5	820	36
	687SB002	19.7			NT		
	687SB003	13.9			33.9		

Table 10.8.4
AOC 687 and SWMU 16
Analytes Detected in Surface, Subsurface Soil, and Sediment

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Barium (Ba) (Continued)	687SB004	26.5			NT		
	687M0001	19.3			NT		
	687M0002	33.3			NT		
Beryllium (Be)	687SB001	0.45	16	0.95	1.2	32	0.67
	687SB002	0.67			NT		
	687SB003	ND			1.1		
	687SB004	0.89			NT		
	687M0002	0.6			NT		
Chromium (Cr) (total)	687SB001	25.2	39	34.5	50.1	19	51.3
	687SB002	33.5			NT		
	687SB003	10.55			46.7		
	687SB004	40			NT		
	687M0001	22.8			NT		
	687M0002	40.25			NT		
Cobalt (Co)	687SB001	2.6	470	5.8	7.4	990	3.48
	687SB002	4.1			NT		
	687SB003	0.895			5.9		
	687SB004	5.3			NT		
	687M0001	2			NT		
	687M0002	3.35			NT		

Table 10.8.4
AOC 687 and SWMU 16
Analytes Detected in Surface, Subsurface Soil, and Sediment

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Copper (Cu)	687SB001	14.5	310	240	25.8	5600	11.5
	687SB002	13.1			NT		
	687SB003	3.6			21.1		
	687SB004	19.1			NT		
	687M0001	33.8			NT		
	687M0002	52			NT		
Lead (Pb)	687SB001	14.5	400	203	27.5	400	12.3
	687SB002	17.8			NT		
	687SB003	11			22.9		
	687SB004	20.4			NT		
	687M0001	30.6			NT		
	687M0002	50.6			NT		
Manganese (Mn)	687SB001	205	160	419	355	480	118
	687SB002	316			NT		
	687SB003	49.75			282		
	687SB004	482			NT		
	687M0001	103			NT		
	687M0002	203			NT		
Mercury (Hg)	687SB004	0.14	2.3	0.47	NT	1	ND

Table 10.8.4
AOC 687 and SWMU 16
Analytes Detected in Surface, Subsurface Soil, and Sediment

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Nickel (Ni)	687SB001	8.4	160	23.9	13.8	65	15.7
	687SB002	9.4			NT		
	687SB003	2.65			12.4		
	687SB004	12.5			NT		
	687M0001	10.2			NT		
	687M0002	16.5			NT		
Selenium (Se)	687SB001	0.84	39	1.49	1.4	2.6	1.77
	687SB002	1.5			NT		
	687SB003	0.76			2		
	687SB004	1.4			NT		
	687M0001	1.5			NT		
	687M0002	2.2			NT		
Tin (Sn)	687M0001	2.6	4700	7.5	NT	5500*	ND
	687M0002	3.45			NT		
Vanadium (V)	687SB001	20.1	55	113	72	3000	38.1
	687SB002	32.1			NT		
	687CB003	15.85			61		
	687SB004	42.6			NT		

Table 10.8.4
AOC 687 and SWMU 16
Analytes Detected in Surface, Subsurface Soil, and Sediment

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Zinc (Zn)	687SB001	47.5	2300	206	76.7	6200	36.2
	687SB002	54.5			NT		
	687SB003	18.9			72.5		
	687SB004	78.4			NT		
	687M0001	289			NT		
	687M0002	515			NT		

Notes:

*	=	Residential RBCs (THQ=0.1) were used as a reference concentration for upper-interval samples. Generic soil-to groundwater SSLs (DAF=10) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996b) were used as a reference concentration for lower-interval samples

Bold concentrations exceed the RBCs, SSL and the zone background
All background values for Zone I are based on twice the means of the grid sample concentrations. Background values for the groundwater are based on two sampling rounds in two wells at each depth.

GW	=	Groundwater
NA	=	Not Applicable/Not Available
ND	=	Not Detected
NT	=	Not Taken
RBC	=	Risk-based concentration
SSL	=	Soil screening level
ng/kg	=	Nanograms per kilogram
mg/kg	=	Micrograms per kilogram
DAF	=	Dilution Attenuation Factor
THQ	=	Target Hazard Quotient
μg/kg	=	Micrograms per kilogram

Semivolatile Organic Compounds in Soil

No SVOCs were detected in soil at the combined sites.

Four SVOCs were detected in surface soil at grid soil boring GDISB008. Bis(2-ethylhexyl)phthalate (100 μg/kg), benzo(b)fluoranthene (81 μg/kg), benzo(k)fluoranthene (97 μg/kg), and pyrene (63 μg/kg) were detected at concentrations far below their RBCs.

Pesticides and PCBs in Soil

The pesticide beta-BHC was detected in surface soil at the combined sites at a range of 1.3 μg/kg to 1.4 μg/kg, at concentrations far below its RBC. The PCB Aroclor-1260 was also detected in surface soil at a range of 27 μg/kg to 35 μg/kg, also below its RBC.

Two pesticides – methoxychlor and beta-BHC – were detected in subsurface soil at the combined sites. Beta-BHC exceeded its respective SSL in subsurface soil sample 687SB00102, at a concentration of 2.5 μg/kg. No PCBs were detected in subsurface soil at the combined sites.

Two pesticides were detected in surface soil at grid soil boring GDISB008. 4,4'-DDE (7.2 μg/kg) and endrin aldehyde (1.9 μg/kg) were detected at concentrations far below their RBCs. No PCBs were detected in surface soil at grid soil boring GDISB008.

Other Organic Compounds in Soil

The organotin tetrabutyltin was detected in subsurface soil sample 687SB00302. No SSL is listed for tetrabutyltin.

Inorganics in Soil

Nineteen metals were detected in surface soil at the combined sites. Chromium exceeded its RBC and surface soil background concentration in sample 687SB00401 (40 mg/kg). Manganese exceeded its RBC and surface soil background concentration in sample 687SB00401 (482 mg/kg). No other surface soil metal concentrations exceeded both their RBCs and surface soil background concentrations.

Eighteen metals were detected in subsurface soil at the combined sites. Arsenic exceeded its respective SSL and subsurface soil background concentration in samples 687SB00102 (17.2 mg/kg), and 687SB00302 (19.8 mg/kg). All other subsurface soil metal concentrations were far below their SSLs and subsurface soil background concentrations.

Twenty-one metals were detected in grid-based surface soil sample GDISB00801 at concentrations similar to those in surface soil samples from the combined sites. Chromium (49.9 mg/kg) exceeded its RBC and surface soil background concentration in this sample. All other metal concentrations were far below their RBCs and surface soil background concentrations.

10.8.3 Groundwater Sampling and Analysis

Four shallow monitoring wells were proposed and installed at the combine sites per the final RFI work plan. Groundwater was sampled in six-rounds at the combined sites. During the first sampling round, wells were sampled for the standard suite of parameters, organotins, chloride, TDS, and sulfate at DQO Level III. Samples from rounds two and three were analyzed for cyanide, and metals (687004 was also sampled for chloride, sulfate, and TDS). Fourth-round samples were analyzed for chloride, cyanide, sulfate, metals, pesticides, PCBs, VOCs and TDS. Fifth-round samples were analyzed for metals and VOCs. Sixth-round samples were analyzed for metals, VOCs, and SVOCs. Table 10.8.5 summarizes the groundwater sampling at AOC 687 and SWMU 16. Figure 10.8.1 earlier in this section shows the well locations.

Table 10.8.5
AOC 687 and SWMU 16
Groundwater Sampling Summary

Sampling Round	Sampling Date	Wells Sampled	Sample Analyses	Comments
1	06/08/95	687001	Standard suite, organotins,	Organotins were
	06/09/95	687002	chloride, TDS, sulfate	collected for site
		687003		characterization.
		687004		
2	01/16/96	687001	Cyanide, metals	
		687002		
	01/17/96	687003		
		687004	Cyanide, metals, chloride, sulfate, TDS	
3	06/04/96	687001	Cyanide, metals	
		687002		
	06/05/96	687003		
		687004	Cyanide, metals, chloride, sulfate, TDS	
4	09/10/96	687001	Chloride, cyanide, sulfate, metals,	
		687002	pesticides, PCBs, VOCs, TDS	
	09/11/96	687003		
		687004		
5	04/14/98	687001	Metals, VOCs	
		687002		
		687003		
		687004		
6	08/18/98	687001	Metals, VOCs, SVOCs	
		687002		
		687003		
		687004		

Note:
Standard suite = VOCs, SVOCs, metals, cyanide, pesticides and PCBs at DQO Level III.

Groundwater samples were also collected from a shallow/deep monitoring well pair (GDI008/GDI08D) near the combined sites. Both were sampled during the six sampling events. During the first four sampling rounds, these wells were sampled for the standard suite of parameters, plus chloride, sulfate, and TDS. GDI00801 was also analyzed for OP-pesticides during the fourth sampling round, while GDI08D01 was analyzed for organotins during the first sampling round. During the fifth sampling round, these wells were sampled for metals and SVOCs. During the sixth sampling round, they were sampled for metals, VOCs, and SVOCs.

Results of these analyses are discussed with the nature and extent of the combined sites and are presented in Appendix D.

The shallow monitoring wells were installed at 12.5 feet bgs in the upper sand layer of the Wando Formation. Deep grid well GDI08D was installed at 44.0 feet bgs. All wells were installed in accordance with Section 3.2.3 of this report.

10.8.4 Nature and Extent of Contamination in Groundwater

Table 10.8.6 summarizes the groundwater analytical results for organics. Table 10.8.7 summarizes the groundwater analytical results for inorganics. Table 10.8.8 summarizes all analytes detected in shallow groundwater at AOC 687/SWMU 16. Appendix D is a complete analytical data report for all samples collected in Zone I.

Volatile Organic Compounds in Groundwater

Two VOCs were detected in shallow groundwater at the combined sites. Acetone was detected during the first sampling round from 687003. Methylene chloride was detected in the first-round samples from wells 687002 and 687003. No other VOCs were detected in groundwater at the combined sites. Except for methylene chloride, all groundwater VOC concentrations were far below their tap-water RBCs and MCLs.

Toluene (2 μg/L) and xylene (total) (2 μg/L) were detected in groundwater samples from nearby shallow grid-based well GDI008 during the second sampling round. Carbon disulfide was detected in deep groundwater at deep grid-based well GDI08D during the first and third sampling rounds at 1 μg/L. All shallow/deep groundwater VOC concentrations were far below their tap-water RBCs.

Table 10.8.6
AOC 687 and SWMU 16
Organic Compound Analytical Results for Groundwater (μg/L)

Parameters	Sample Round	Detection Frequency	Detection Range	Mean	Tap-water RBC/MCL	Number of Samples Exceeding RBC or MCL
Volatile Organic Compounds						
Acetone	First	1/4	8.0	8.0	370/NL	0
	Second	0/0	NA	NA		0
	Third	0/0	NA	NA		0
	Fourth	0/4	ND	ND		0
	Fifth	0/4	ND	ND		0
	Sixth	0/4	ND	ND		0
Methylene chloride	First	2/4	2.0 - 15.0	8.5	4.1/NL	1
	Second	0/0	NA	NA		0
	Third	0/0	NA	NA		0
	Fourth	0/4	ND	ND		0
	Fifth	0/4	ND	ND		0
	Sixth	0/4		ND		0
Semivolatile Organic Compounds						
Bis(2-ethylhexyl)phthalate	First	0/4	ND	ND	4.8/NL	0
	Second	0/0	ND	ND		0
	Third	0/0	ND	ND		0
	Fourth	0/0	ND	ND		0
	Fifth	0/0	ND	ND		0
	Sixth	0/4	ND	ND		0
Isophorone	First	0/4	ND	ND	70/NL	0
	Second	0/0	ND	ND		0
	Third	0/0	ND	ND		0
	Fourth	0/0	ND	ND		0
	Fifth	0/0	ND	ND		0
	Sixth	1/4	1.0	1.0		0

Notes:
NA = Not Available/Not Applicable/Not Analyzed
ND = Not Detected/Not Determined
NL = Not Listed
See Table 5.5 for inorganic screening concentrations and their sources.

Table 10.8.7
AOC 687 and SWMU 16
Inorganic Analytical Results for Groundwater (μg/L)

Parameters	Sample Round	Detection Frequency	Detection Range	Mean	Tap-water RBC/MCL	Shallow Groundwater Background	Number of Samples Exceeding lower of the RBC or MCL, and Background
Aluminum (Al)	First	0/4	ND	ND	3,700/NL	1,440	0
	Second	0/4	ND	ND			0
	Third	0/4	ND	ND			0
	Fourth	1/4	209	209			0
	Fifth	3/4	300 - 1,000	537			0
	Sixth	0/4	ND	ND			0
Arsenic (As)	First	3/4	6.3 - 38.6	26.0	0.045/50	23	2
	Second	1/4	ND - 73.7	73.7			1
	Third	1/4	5.6	5.6			0
	Fourth	1/4	39.3	39.3			1
	Fifth	3/4	4.1 - 131	47.8			1
	Sixth	4/4	3.3 - 58.3	17.3			1
Barium (Ba)	First	0/4	ND	ND	260/2,000	110	0
	Second	4/4	16.6 - 22.2	19.7			0
	Third	0/4	ND	ND			0
	Fourth	4/4	13.0 - 20.8	16.0			0
	Fifth	3/4	17.7 - 25.1	21.1			0
	Sixth	4/4	22.3 - 49.3	34.8			0
Beryllium (Be)	First	0/4	ND	ND	7.3/4	1.1	0
	Second	0/4	ND	ND			0
	Third	0/4	ND	ND			0
	Fourth	4/4	0.33 - 0.4	0.38			0
	Fifth	0/4	ND	ND			0
	Sixth	1/4	0.30	0.30			0
Calcium (Ca)	First	4/4	164,000 - 235,000	208,000	NL/NL	NL	NA
	Second	4/4	201,000 - 264,000	226,000			NA
	Third	4/4	193,000 - 276,000	225,000			NA
	Fourth	4/4	199,000 - 309,000	242,000			NA
	Fifth	4/4	193,000 - 254,000	216,000			NA
	Sixth	4/4	236,000 - 449,000	317,000			NA
Chromium (Cr)	First	3/4	1.5 - 4.6	2.7	18/100	14.3	0
	Second	0/4	ND	ND			0
	Third	1/4	1.7	1.7			0
	Fourth	0/4	ND	ND			0
	Fifth	0/4	ND	ND			0
	Sixth	4/4	12.7 - 26.1	20.1			3
Cobalt (Co)	First	0/4	ND	ND	220/NL	2.2	0
	Second	1/4	3.1	3.1			0
	Third	0/4	ND	ND			0
	Fourth	0/4	ND	ND			0
	Fifth	2/4	1.3 - 1.9	1.6			0
	Sixth	3/4	4.0 - 4.7	4.33			0

Table 10.8.7
AOC 687 and SWMU 16
Inorganic Analytical Results for Groundwater (μg/L)

Parameters	Sample Round	Detection Frequency	Detection Range	Mean	Tap-water RBC/MCL	Shallow Groundwater Background	Number of Samples Exceeding lower of the RBC or MCL, and Background
Copper (Cu)	First	0/4	ND	ND	150/1,300	4.4	0
	Second	1/1	2.1	2.1			0
	Third	0/4	ND	ND			0
	Fourth	2/4	11.4 - 12.3	11.9			0
	Fifth	1/4	29.3	29.3			0
	Sixth	4/4	3.4 - 16.9	10.2			0
Iron (Fe)	First	4/4	2,480 - 4,420	3,390	NL/NL	NL	NA
	Second	4/4	879 - 8,570	3,840			NA
	Third	2/4	1,740 - 3,490	2,620			NA
	Fourth	3/4	211 - 3,950	1,780			NA
	Fifth	4/4	542 - 13,700	5,830			NA
	Sixth	4/4	795 - 4,420	2,429			NA
Lead (Pb)	First	3/4	2.1 - 4.0	2.9	15/15	4.4	0
	Second	0/4	ND	ND			0
	Third	0/4	ND	ND			0
	Fourth	0/4	ND	ND .			0
	Fifth	0/4	ND	ND			0
	Sixth	0/4	ND	ND			0
Magnesium (Mg)	First	4/4	111,000 - 140,000	123,000	NL/NL	NL	NA
	Second	4/4	89,500 - 120,000	101,000			NA
	Third	4/4	108,000 - 171,000	126,000			NA
	Fourth	4/4	59,900 - 92,800	78,400			NA
	Fifth	4/4	57,100 - 257,000	120,000			NA
	Sixth	4/4	91,000 - 160,000	125,075			NA
Manganese (Mn)	First	4/4	165 - 1,330	735	73/NL	5,430	0
	Second	4/4	327 - 3,290	1,660			0
	Third	2/4	215 - 1,750	983			0
	Fourth	4/4	43.5 - 134	94.6			0
	Fifth	4/4	280 - 2,220	1,020			0
	Sixth	4/4	223 - 2,820	1,046			0
Nickel (Ni)	First	4/4	2.0 - 23.9	11.9	73/100	13.3	0
	Second	3/4	1.5 - 24	9.9			0
	Third	2/4	1.1 - 2.0	1.6			0
	Fourth	2/4	11.1 - 15.7	13.4			0
	Fifth	1/4	19.3	19.3			0
	Sixth	4/4	6.5 - 23.9	11.6			0
Potassium (K)	First	4/4	60,300 - 105,000	76,100	NL/NL	NL	NA
	Second	4/4	35,600 - 45,200	41,600			NA
	Third	4/4	39,400 - 56,800	46,800			NA
	Fourth	4/4	23,300 - 42,500	34,900			NA
	Fifth	4/4	28,400 - 86,800	48,000			NA
	Sixth	4/4	38,300 - 64,700	50,500			NA

Table 10.8.7
AOC 687 and SWMU 16
Inorganic Analytical Results for Groundwater (μg/L)

Parameters	Sample Round	Detection Frequency	Detection Range	Mean	Tap-water RBC/MCL	Shallow Groundwater Background	Number of Samples Exceeding lower of the RBC or MCL, and Background
Selenium (Se)	First	0/4	ND	ND	18/50	ND	0
	Second	0/4	ND	ND			0
	Third	0/4	ND	ND			0
	Fourth	4/4	3.4 - 8.5	5.0			0
	Fifth	0/4	ND	ND			0
	Sixth	1/4	0.93	0.93			0
Sodium (Na)	First	4/4	375,000 - 895,000	541,000	NL/NL	NL	NA
	Second	4/4	389,000 - 509,000	453.000			NA
	Third	4/4	470,000 - 945,000	644,000			NA
	Fourth	4/4	1,980 - 361,000	170,000			NA
	Fifth	4/4	192,000 - 1,390,000	553,000			NA
	Sixth	4/4	296,000 - 674,000	465,750			NA
Tin (Sn)	First	4/4	104 - 221	177	2,200/NL	NA	0
	Second	0/4	ND	ND			0
	Third	0/4	ND	ND			0
	Fourth	0/4	ND	ND			0
	Fifth	0/4	ND	ND			0
	Sixth	0/4	ND	ND			0
Thallium (Tl)	First	0/4	ND	ND	0.26/2	2.0	0
	Second	0/4	ND	ND			0
	Third	0/4	ND	ND			0
	Fourth	2/4	2.7 - 5.2	4.0			2
	Fifth	0/4	ND	ND			0
	Sixth	0/4	ND	ND			0
Vanadium (V)	First	0/4	ND	ND	26/NL	14	0
	Second	4/4	1.0 - 1.8	1.2			0
	Third	0/4	ND	ND			0
	Fourth	2/4	5.7 - 6.2	6.0			0
	Fifth	0/4	ND	ND			0
	Sixth	4/4	3.1 - 5.0	3.95			0
Zinc (Zn)	First	4/4	23.3 - 41.4	33.8	1,100/NL	24.4	0
	Second	2/4	4.5 - 8.1	6.3			0
	Third	1/4	29.7	29.7			0
	Fourth	2/4	6.4 - 8.4	7.4			0
	Fifth	1/4	14.6	14.6			0
	Sixth	4/4	9.1 - 23.4	16.1			0

Notes:
NA = Not Applicable/Not Available
ND = Not Detected/Not Determined
NL = Not Listed
μg/L = Micrograms per liter
See Table 5.6 for inorganic screening concentrations and their sources.

Table 10.8.8
AOC 687 and SWMU 16
Analytes Detected in Shallow Groundwater (μg/L)

Parameter	Location	1st Round	2nd Round	3rd Round	4th Round	5th Round	6th Round	Tap-water RBC*	MCL/SMCL*	Shallow Background
Volatile Organic Compounds										
Acetone	687GW003	8	NT	NT	ND	ND	ND	370	NA	NA
Methylene chloride	687GW002	15	NT	NT	ND	ND	ND	4.1	NA	NA
	687GW003	2	NT	NT	ND	ND	ND			
Semivolatile Organic Compounds										
bis(2-Ethylhexyl)phthalate	687GW001	ND	NT	NT	NT	NT	ND	4.8	NA	NA
(BEHP)	687GW002	ND	NT	NT	NT	NT	ND			
	687GW003	ND	NT	NT	NT	NT	ND			
	687GW004	ND	NT	NT	NT	NT	ND			
Inorganics										
Aluminum (Al)	687GW002	ND	ND	ND	ND	1000	ND	3700	NL	1440
	687GW003	ND	ND	ND	ND	300	ND			
	687GW004	ND	ND	ND	209	311	ND			
Arsenic (As)	687GW001	38.6	ND	ND	ND	ND	3.3	0.045	50	23
	687GW002	33.2	73.7	ND	39.3	131	58.3			
	687GW003	ND	ND	5.6	ND	4.1	4.3			
	687GW004	6.3	ND	ND	ND	8.2	3.3			
Barium (Ba)	687GW001	ND	19.3	ND	20.8	ND	42.7	260	2000	110
	687GW002	ND	16.6	ND	13.8	25.1	25			
	687GW003	ND	22.2	ND	13	17.7	22.3			
	687GW004	ND	20.7	ND	16.4	20.6	49.3			

Table 10.8.8
AOC 687 and SWMU 16
Analytes Detected in Shallow Groundwater (μg/L)

Parameter	Location	1st Round	2nd Round	3rd Round	4th Round	5th Round	6th Round	Tap-water RBC*	MCL/SMCL*	Shallow Background
Beryllium (Be)	687GW001	ND	ND	ND	0.4	ND	ND	7.3	4	1.1
	687GW002	ND	ND	ND	0.38	ND	ND			
	687GW003	ND	ND	ND	0.33	ND	0.3			
	687GW004	ND	ND	ND	0.39	ND	ND			
Chromium (Cr) (total)	687GW001	ND	ND	ND	ND	ND	20.9	18	100	14.3
	687GW002	2.1	ND	ND	ND	ND	12.7			
	687GW003	4.6	ND	1.7	ND	ND	20.7			
	687GW004	1.5	ND	ND	ND	ND	26.1			
Cobalt (Co)	687GW001	ND	3.1	ND	ND	1.9	4.3	220	NL	2.2
	687GW003	ND	ND	ND	ND	ND	4.7			
	687GW004	ND	ND	ND	ND	1.3	4			
Copper (Cu)	687GW001	ND	2.1	ND	12.3	ND	16.9	150	1300	4.4
	687GW002	ND	ND	ND	ND	29.3	3.4			
	687GW003	ND	ND	ND	ND	ND	6.5			
	687GW004	ND	ND	ND	11.4	ND	13.8			
Lead (Pb)	687GW001	4	ND	ND	ND	ND	ND	15	15	4.4
	687GW002	2.6	ND	ND	ND	ND	ND			
	687GW004	2.1	ND	ND	ND	ND	ND			

Table 10.8.8
AOC 687 and SWMU 16
Analytes Detected in Shallow Groundwater (μg/L)

Parameter	Location	1st Round	2nd Round	3rd Round	4th Round	5th Round	6th Round	Tap-water RBC*	MCL/SMCL*	Shallow Background
Manganese (Mn)	687GW001	1330	3290	ND	43.5	1270	735	73	NL	5430
	687GW002	165	327	ND	115	326	223			
	687GW003	404	796	1750	134	280	404			
	687GW004	1040	2240	215	85.8	2220	2820			
Nickel (Ni)	687GW001	19.4	ND	ND	ND	ND	7.2	73	100	13.3
	687GW002	23.9	24	1.1	15.7	19.3	23.9			
	687GW003	2	1.5	2	11.1	ND	6.5			
	687GW004	2.4	4.2	ND	ND	ND	8.6			
Selenium (Se)	687GW001	ND	ND	ND	3.4	ND	0.93	18	50	ND
	687GW002	ND	ND	ND	8.5	ND	ND			
	687GW003	ND	ND	ND	4.1	ND	ND			
	687GW004	ND	ND	ND	3.9	ND	ND			
Thallium (Tl)	687GW001	ND	ND	ND	5.2	ND	ND	0.26	2	6.6#
	687GW002	ND	ND	ND	2.7	ND	ND			
Tin (Sn)	687GW001	104	ND	ND	ND	ND	ND	2200	NL	NA
	687GW002	221	ND	ND	ND	ND	ND			
	687GW003	172	ND	ND	ND	ND	ND			
	687GW004	210	ND	ND	ND	ND	ND			

Table 10.8.8
AOC 687 and SWMU 16
Analytes Detected in Shallow Groundwater (μg/L)

Parameter	Location	1st Round	2nd Round	3rd Round	4th Round	5th Round	6th Round	Tap-water RBC*	MCL/SMCL*	Shallow Background
Vanadium (V)	687GW001	ND	1	ND	ND	ND	3.1	26	NL	14
	687GW002	ND	1	ND	ND	ND	4.3			
	687GW003	ND	1.1	ND	6.2	ND	5			
	687GW004	ND	1.8	ND	5.7	ND	3.4			
Zinc (Zn)	687GW001	23.3	4.5	29.7	ND	ND	23.4	1100	NL	24.4
	687GW002	41.4	8.1	ND	6.4	14.6	14.8			
	687GW003	34.8	ND	ND	8.4	ND	9.1			
	687GW004	35.7	ND	ND	ND	ND	16.9			

Notes:
a = Background value for non clay samples
* = Tap-water RBCs (THQ=0.1) from *Risk-Based Concentration Table* (USEPA, October 22, 1997), and MCLs/SMCLs from *Drinking Water Regulations and Health Advisories* (USEPA, 1996e).
1 = Calculated from methods described in USEPA Interim *Supplemental Guidance to RAGS: Human Health Risk Assessment*, Bulletin 2 (USEPA, 1995c).
Bold concentrations exceed both the RBC and the zone background.
All background values for Zone I are based on twice the means of the grid sample concentrations. Background values for the groundwater are based on two sampling rounds in two wells at each depth.
ND = Not Detected
NL = Not Listed
RBC = Risk-based concentration
mg/k = Micrograms per kilograms
μg/L = milligrams per liter

Semivolatile Organic Compounds in Groundwater

One SVOC was detected in shallow groundwater at the combined sites. Isophorone was detected in one well during the sixth-round of groundwater sampling. All groundwater SVOC concentrations were far below their tap-water RBCs and MCLs.

No SVOCs were detected in shallow groundwater at nearby shallow grid-based well GDI008. During the third sampling round, benzoic acid (1.0 μg/L) was detected in deep groundwater at grid-based well GDI08D. It was far below its tap-water RBC. No other SVOCs were detected in deep groundwater at GDI08D.

Pesticides and PCBs in Groundwater

No pesticides or PCBs were detected in shallow groundwater at the combined sites.

Beta-BHC (0.22 μg/L) and parathion (0.17 μg/L) were detected in shallow groundwater at grid-based well GDI008 during the first sampling round at concentrations far below their tap-water RBCs. No other pesticides were detected at GDI008. No pesticides were detected in groundwater from deep grid-based well GDI08D. No PCBs were detected in shallow or deep groundwater at GDI008/GDI08D.

Other Organics in Groundwater

Dioxins and furans were detected in the shallow groundwater duplicate sample collected during the first sampling round from shallow grid-based well GDI008. In accordance with recent dioxin guidance (USEPA *Interim Supplemental Guidance to RAGS: Region IV Bulletins Human Health Risk Assessment*, Bulletin No. 2 [USEPA 1995c] and Section 7 of this report, a TEQ of 1.55E-7 μg/L was calculated for the first sampling round at GDI008. The calculated TEQ is below the tap-water RBC of 4.5E-7 μg/L.

Inorganics in Groundwater

Twenty metals were detected in shallow groundwater at the combined sites. Arsenic exceeded its tap-water RBC and shallow background concentration at well 687002 during the first (33.2 μg/L), second (73.7 μg/L), fourth (39.3 μg/L), fifth (131 μg/L), and sixth (58.3 μg/L) sampling rounds. Arsenic also exceeded its tap-water RBC and shallow background standard at 687001 (38.6 μg/L) during the first sampling round. Chromium exceeded its tap-water RBC and shallow background concentration in well 687001 (20.9 μg/L), 687003 (20.7 μg/L), and 687004 (26.1 μg/L) during the sixth sampling round. Thallium exceeded its tap-water RBC, MCL, and shallow background concentration at wells 687001 (5.2 μg/L) and 687002 (2.7 μg/L) during the fourth sampling round. No other metals exceeded their tap-water RBC, MCL, or shallow background concentration at the combined sites.

Sixteen metals were detected in shallow groundwater at GDI008. Antimony (5.6 μg/L) exceeded its tap-water RBC during the third sampling round. Chromium (22.7 μg/L) exceeded its tap-water RBC and shallow background during the sixth sampling round. All other shallow groundwater metal concentrations were far below their tap-water RBCs, MCLs, and shallow groundwater background concentrations.

Thirteen metals plus cyanide were detected in deep groundwater at GDI08D. During the second sampling round, thallium (5.5 μg/L) exceeded its tap-water RBC, MCL, and deep groundwater background concentration. During the third sampling round, antimony (5.4 μg/L) exceeded its tap-water RBC. All other deep groundwater metal/cyanide concentrations were far below their tap-water RBCs, MCLs, and deep groundwater background concentrations.

10.8.5 Sediment Sampling and Analysis

Sediment was sampled at the combined sites from the locations shown previously on in Figure 10.8.1. The final RFI work plan proposed two sediment samples. These two samples, 687M0001 and 687M0002, were collected from a drainage ditch immediately east of the site to characterize potential contamination from surface water runoff within the site area. The two sediment samples collected were analyzed for organotins and the standard suite (VOCs, SVOCs, metals, cyanide, pesticides and PCBs) at DQO Level III. They were also analyzed for TOC and grain size. One duplicate sample was analyzed for Appendix IX analysis at DQO Level IV. Table 10.8.9 summarizes the sediment sampling and analysis at the combined sites.

Table 10.8.9
AOC 687 and SWMU 16
Sediment Sampling Summary

Sampling Round	Sampling Date	Samples Collected	Sample Analyses	Comments
1	06/22/95	2 (2)	Standard suite, TOC, grain size, organotins	
		Duplicate - 1	Appendix IX, TOC, grain size	

Notes:
( ) = Parentheses indicate number of samples proposed.
Standard suite = VOCs, SVOCs, metals, cyanide, pesticides and PCBs at DQO Level III.

10.8.6 Nature and Extent of Contamination in Sediment

Organic compound analytical data for sediment are summarized in Table 10.8.10. Inorganic analytical data for sediment are summarized in Table 10.8.11. Table 10.8.4 previously summarized the analytes detected in sediments at AOC 687/SWMU 16. Appendix D is a complete analytical data report for all samples collected in Zone I.

Volatile Organic Compounds in Sediment

No VOCs were detected in sediment at the combined sites.

Semivolatile Organic Compounds in Sediment

Fifteen SVOCs were detected in sediment samples at the combined sites. Most SVOC detections occurred at 687M0002. Five PAH detections at sample location 687M0002: benzo(a)anthracene (580 μg/kg), benzo(a)pyrene (790 μg/kg), chrysene (1,650 μg/kg), fluoranthene (2,100 μg/kg) and pyrene (1,650 μg/kg). Bis(2-ethylhexyl)phthalate was detected at location 687M0002 (250 μg/kg). Three SVOCs (fluoranthene, pyrene, and bis (2-ethylhexyl) phthalate) were detected at sample location 687M0001.

Table 10.8.10
AOC 687 and SWMU 16
Organic Compound Analytical Results for Sediment (μg/kg)

Parameters	Frequency of Detection	Range of Detection	Mean
Semivolatile Organic Compounds			
BEQs	1/2	1,300	1,300
Benzo(a)anthracene	1/2	580	580
Benzo(a)pyrene	1/2	790	790
Benzo(b)fluoranthene	1/2	2,650	2,650
Benzo(k)fluoranthene	1/2	2,950	2,950
Chrysene	1/2	1,650	1,650
Dibenz(a,h)anthracene	1/2	120	120
Indeno(1,2,3-cd)pyrene	1/2	405	405
1-Methylnaphthalene	1/2	80.0	80.0
Acenaphthylene	1/2	63.0	63.0
Anthracene	1/2	94.5	94.5
Benzo(g,h,i)perylene	1/2	405	405
Fluoranthene	2/2	49.0 - 2,100	1,070
Phenanthrene	1/2	225	225
Pyrene	2/2	38.0 - 1,650	844
bis(2-Ethylhexyl)phthalate (BEHP)	2/2	180 - 250	215
Pesticides and PCBs			
4,4'-DDD	1/2	20.5	20.5
4,4'-DDE	2/2	3.3 - 129	65.9
4,4'-DDT	2/2	1.1 - 6.9	4.0
Aldrin	2/2	0.057 - 1.3	0.65
Chlordane	1/2	5,250	5,250
Dieldrin	2/2	1.9 - 2.04	2.0
Endosulfan I	1/2	1.4	1.4

Table 10.8.10
AOC 687 and SWMU 16
Organic Compound Analytical Results for Sediment (μg/kg)

Parameters	Frequency of Detection	Range of Detection	Mean
Endosulfan II	2/2	0.96 - 3.0	2.0
Endosulfan sulfate	1/2	2.8	2.8
Endrin	2/2	0.96 - 8.4	4.7
Pesticides and PCBs			
Endrin aldehyde	2/2	1.2 - 57.0	29.1
Heptachlor	1/2	3.0	3.0
Heptachlor epoxide	1/2	36.7	36.7
Methoxychlor	2/2	2.0 - 8.7	5.4
beta-BHC	1/2	3.4	3.4
delta-BHC	2/2	0.83 - 1.6	1.2
Organophosphorous Pesticides			
Parathion	1/1	9.6	9.6
Dimethoate	1/1	36.0	36.0
Herbicides			
2,4,5-T	1/1	7.80	7.80
2,4,5-TP (Silvex)	1/1	120	120
Dioxin Compounds and Organotins			
TEQs	1/1	1.18E-04	1.18E-04
1,2,3,4,6,7,8-HpCDD	1/1	6.36E-03	6.36E-03
1,2,3,4,6,7,8-HpCDF	1/1	1.25E-03	1.25E-03
OCDD	1/1	3.94E-02	3.94E-02
OCDF	1/1	2.66E-03	2.66E-03

Note:
μg/kg = micrograms per kilogram

Table 10.8.11
AOC 687 and SWMU 16
Inorganic Analytical Results for Sediment (mg/kg)

Parameters	Frequency of Detection	Range of Detection	Mean
Aluminum (Al	2/2	8,420 - 15,000	11,700
Antimony (Sb)	2/2	0.58 - 0.77	0.68
Arsenic (As)	2/2	6.9 - 11.9	9.4
Barium (Ba)	2/2	19.3 - 33.3	26.3
Beryllium (Be)	1/2	0.60	0.60
Calcium (Ca)	2/2	29,200 - 52,100	40,700
Chromium (Cr)	2/2	22.8 - 40.3	31.5
Cobalt (Co)	2/2	2.0 - 3.4	2.7
Copper (Cu)	2/2	33.8 - 52.0	42.9
Iron (Fe)	2/2	8,510 - 13,900	11,200
Lead (Pb)	2/2	30.6 - 50.6	40.6
Magnesium (Mg)	2/2	1,820 - 3,910	2,870
Manganese (Mn)	2/2	103 - 203	153
Nickel (Ni)	2/2	10.2 - 16.5	13.4
Potassium (K)	2/2	894 - 1,560	1,230
Selenium (Se)	2/2	1.5 - 2.2	1.9
Sodium (Na)	2/2	717 - 1,125	921
Tin (Sn)	2/2	2.6 - 3.5	3.0
Zinc (Zn)	2/2	289 - 515	402

Notes:
mg/kg = milligram per kilogram

In accordance with recent cPAH guidance, a BEQ of 1,300 μg/kg was calculated for sediment sample 687M000201.

Pesticides and PCBs in Sediment

Sixteen pesticides were detected in sediment samples at the combined sites. Most were at sample location 687M0002. Nine pesticides were detected at sample location 687M0001. No PCBs were detected in sediment samples at the combined sites.

Other Organic Compounds in Sediment

Two organophosphorous pesticides – parathion and dimethoate – were detected at sample location 687M0002.

Two herbicides (2,4,5-T and 2,4,5-TP) were detected at sample location 687M0002.

Two dioxins and two furans were detected at sample location 687M000201. In accordance with recent dioxin guidance, a TEQ of 1.18E-04 μg/kg was calculated.

Inorganics in Sediment

Nineteen metals were detected in sediment samples at the combined sites. The highest detections were at 687M0002.

10.8.7 Fate and Transport Assessment

AOC 687 consists of Building X-55, an earth covered ammunition storage bunker constructed in 1942. The concrete walls and ceiling of the bunker are 4 feet thick. The entire structure is covered by 2 feet of soil. Surrounding the bunker, is a cement and soil containment berm designed to control the bunker door in the event of an explosion. The storage bunker is approximately 29 feet wide, 52 feet long, and 12 feet high. The area is surrounded by a chain-link fence. The AOC is located between Juneau Avenue and the Dredged Materials Area (DMA). The Cooper River and associated wetlands are to the east of the site across Juneau Avenue.

The bunker appears to have been used for ammunition storage since its construction in 1942. No other uses are known. At the time of the RFA, explosives and small arms ammunition were stored in the bunker. The magazine is currently empty, although no information is available regarding the dates of explosive/ammunition removal.

SWMU 16 (the earthen roof of Building X-55) has been associated with AOC 687 due to prior unauthorized storage of potentially hazardous material (empty paint containers). This paint container storage was identified as a one time occurrence and is not thought to represent a historical problem. Minor spills associated with the storage of the paint containers were cleaned and the paint containers themselves were removed from the site at the time of discovery.

Environmental media sampled as part of this investigation are surface soil, subsurface soil, sediment, and shallow groundwater. Potential constituent migration pathways investigated are soil-to-groundwater, groundwater-to-human, groundwater-to-surface water, soil-to-sediment, and emission of volatiles from surface soil-to-air.

10.8.7.1 Soil-to-Groundwater Cross-Media Transport

Tables 10.8.12 and 10.8.13 compare maximum detected organic and inorganic constituent concentrations respectively in surface soil and subsurface soil samples to risk-based soil screening levels considered protective of groundwater. Maximum concentrations in soil are compared to leachability-based generic SSLs. Soil background values for inorganics in Zone I were determined, but at the request of SCDHEC were not considered during initial comparisons of maximum soil concentrations with SSLs. To provide a conservative screen, generic SSLs are used; leachate entering the aquifer is assumed to be diluted by a ratio of 10:1, with no attenuation of constituents in soil (DAF=10).

Two organic constituents - methylene chloride and beta-BHC - were detected in soil at concentrations that exceed their SSL. Methylene chloride was detected in one of four surface soil samples, but was nondetect in subsurface soil. Figure 10.8.2 presents methylene chloride concentrations detected at AOC 687/SWMU 16. This constituent could be associated with past site activities (namely, unauthorized paint and thinner storage). The absence of methylene chloride in subsurface soil effectively invalidates the pathway for this constituent. However, considering the presence of acetone in soil and methylene chloride in groundwater, the data suggest that these VOCs may be residual contaminants on the site. Beta BHC was present in only one surface and one subsurface soil sample and only at concentrations slightly exceeding its SSL. Figure 10.8.3 presents beta-BHC concentrations detected at AOC 687/SWMU 16. It would not be unexpected to detect pesticides in this area of the base a result of as normal application. The levels of this pesticide are not overly remarkable, nor are they laterally persistent. Therefore, the significance of the pathway is not expected to be great, although the SSL is exceeded and the pathway is valid. This conclusion is substantiated by the pesticides' absence in groundwater.

Three inorganics - arsenic, chromium, and manganese - were detected in soil at concentrations that exceeded their SSLs: Arsenic was widely detected, was greater than the SSL only in the subsurface samples, and was below the zone-specific background in all samples. Figure 10.8.4 presents arsenic concentrations detected at AOC 687/SWMU 16. Chromium was widely detected at concentrations generally greater then the SSL, but was also below the zone-specific background in all samples. Figure 10.8.5 presents chromium detections at AOC 687/SWMU 16. Manganese was also widely detected, and was below the SSL and zone-specific background in subsurface samples. Figure 10.8.6 presents manganese detections at AOC 687/SWMU 16. All three inorganics are consistently detected in zone-wide soil; given these widespread occurrences zone-wide and at this AOC, it is unlikely that they represent residual site contamination. The presence of arsenic, chromium, and manganese in site groundwater suggests that the pathway is valid for these constituents, but the background concentrations of each should be acknowledged as the point of departure for risk management.

Table 10.8.12
Organic Chemicals Detected in Surface Soil, Subsurface Soil, Sediment, and Shallow Groundwater
Comparison to Cross-Media SSLs, Tap-Water RBCs, and Saltwater Surface Water Chronic Screening Levels
AOC 687, SWMU 16
Charleston Naval Complex
Charleston, South Carolina

Parameter	Maximum Concentration: Surface Soil	Subsurface Soil	Sediment	Shallow GW	Screening Concentration: Soil to GW SSL	Soil to Air SSL	Tap Water RBC	Saltwater Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Volatilization Potential	Groundwater Migration Concern	Surface Water Migration Concern
Volatile Organic Compounds														
Acetone	8.5	22	ND	8	8000	1.0E+08	3700	NA	µG/KG	µG/L	NO	NO	NO	NO
Methylene chloride c	28	ND	ND	15	10	13000	4.1	2560	µG/KG	µG/L	YES	NO	YES	NO
Semivolatile Organic Compounds														
Acenaphthylene	ND	ND	63	ND	96000 a	NA	1500	NA	µG/KG	µG/L	NO	NO	NO	NO
Anthracene	ND	ND	94.5	ND	5900000	NA	11000	NA	µG/KG	µG/L	NO	NO	NO	NO
Benzo(g,h,i)perylene	ND	ND	405	ND	1.2E+08 a	NA	1500	NA	µG/KG	µG/L	NO	NO	NO	NO
Benzo(a)pyrene Equivalents c	ND	ND	1305	ND	1600 a	NA	0.0092	NA	µG/KG	µG/L	NO	NO	NO	NO
Benzo(a)anthracene c	ND	ND	580	ND	800	NA	0.092	NA	µG/KG	µG/L	NO	NO	NO	NO
Benzo(a)pyrene c	ND	ND	790	ND	4000	NA	0.0092	NA	µG/KG	µG/L	NO	NO	NO	NO
Benzo(b)fluoranthene c	ND	ND	2650	ND	2500	NA	0.092	NA	µG/KG	µG/L	NO	NO	NO	NO
Benzo(k)fluoranthene c	ND	ND	2950	ND	25000	NA	0.92	NA	µG/KG	µG/L	NO	NO	NO	NO
Chrysene c	ND	ND	1650	ND	80000	NA	9.2	NA	µG/KG	µG/L	NO	NO	NO	NO
Dibenz(a,h)anthracene c	ND	ND	120	ND	800	NA	0.0092	NA	µG/KG	µG/L	NO	NO	NO	NO
Indeno(1,2,3-cd)pyrene c	ND	ND	405	ND	7000	NA	0.092	NA	µG/KG	µG/L	NO	NO	NO	NO
bis(2-Ethylhexyl)phthalate (BEHP) c	ND	ND	250	1	1800000	31000000	4.8	NA	µG/KG	µG/L	NO	NO	NO	NO
Fluoranthene	ND	ND	2100	ND	2100000	NA	1500	1.6	µG/KG	µG/L	NO	NO	NO	NO
Isophorone	ND	ND	ND	1	260	4600000	70	129	µG/KG	µG/L	NO	NO	NO	NO
1-Methylnaphthalene	ND	ND	80	ND	72000 a	NA	1500	NA	µG/KG	µG/L	NO	NO	NO	NO
Phenanthrene	ND	ND	225	ND	660000 a	NA	1100	NA	µG/KG	µG/L	NO	NO	NO	NO
Pyrene	ND	ND	1650	ND	2100000	NA	1100	NA	µG/KG	µG/L	NO	NO	NO	NO
Pesticides/PCBs														
Aldrin c	ND	ND	1.3	ND	230	3000	0.0039	0.13	µG/KG	µG/L	NO	NO	NO	NO
Aroclor-1260 c	35	ND	ND	ND	1000	1000	0.033	0.03	µG/KG	µG/L	NO	NO	NO	NO
beta-BHC (beta-HCH) c	1.4	2.5	3.4	ND	1.3	1E+09	0.037	NA	µG/KG	µG/L	YES	NO	NO	NO
delta-BHC (delta-HCH) c	ND	ND	1.6	ND	1.8 a	NA	0.037	NA	µG/KG	µG/L	NO	NO	NO	NO
Chlordane c	ND	ND	5250	ND	5000	20000	0.19	0.004	µG/KG	µG/L	NO	NO	NO	NO
4,4'-DDD c	ND	ND	20.5	ND	8000	NA	0.28	0.025	µG/KG	µG/L	NO	NO	NO	NO
4,4'-DDE c	ND	ND	129	ND	27000	NA	0.2	0.14	µG/KG	µG/L	NO	NO	NO	NO
4,4'-DDT c	ND	ND	6.9	ND	16000	1E+09	0.2	0.001	µG/KG	µG/L	NO	NO	NO	NO
Dieldrin c	ND	ND	2.04	ND	2	1000	0.0042	0.0019	µG/KG	µG/L	NO	NO	NO	NO
Endosulfan I	ND	ND	1.4	ND	9000 b	NA	220	0.0087	µG/KG	µG/L	NO	NO	NO	NO
Endosulfan II	ND	ND	3	ND	9000 b	NA	220	0.0087	µG/KG	µG/L	NO	NO	NO	NO
Endosulfan sulfate	ND	ND	2.8	ND	4600 a	NA	220	NA	µG/KG	µG/L	NO	NO	NO	NO

Table 10.8.12
Organic Chemicals Detected in Surface Soil, Subsurface Soil, Sediment, and Shallow Groundwater
Comparison to Cross-Media SSLs, Tap-Water RBCs, and Saltwater Surface Water Chronic Screening Levels
AOC 687, SWMU 16
Charleston Naval Complex
Charleston, South Carolina

Parameter	Maximum Concentration Surface Soil	Maximum Concentration Subsurface Soil	Maximum Concentration Sediment	Maximum Concentration Shallow GW	Screening Concentration Soil to GW SSL	Screening Concentration Soil to Air SSL	Screening Concentration Tap Water RBC	Screening Concentration Saltwater Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Volatilization Potential	Groundwater Migration Concern	Surface Water Migration Concern
Endrin	ND	ND	8.4	ND	500	NA	11	0.0023	µG/KG	µG/L	NO	NO	NO	NO
Endrin aldehyde	ND	ND	57	ND	340 a	NA	11	NA	µG/KG	µG/L	NO	NO	NO	NO
Heptachlor c	ND	ND	3	ND	11000	100	0.0023	0.0036	µG/KG	µG/L	NO	NO	NO	NO
Heptachlor epoxide c	ND	ND	36.7	ND	330	5000	0.0012	0.0036	µG/KG	µG/L	NO	NO	NO	NO
Methoxychlor	ND	8.6	8.7	ND	80000	NA	180	0.03	µG/KG	µG/L	NO	NO	NO	NO
Organophosphate Pesticides														
Dimethoate	NA	NA	36	NA	15 a	NA	7.3	NA	µG/KG	µG/L	NO	NO	NO	NO
Parathion	NA	NA	9.6	NA	27000 a	110000	220	0.178	µG/KG	µG/L	NO	NO	NO	NO
Herbicides														
2,4,5-T	NA	NA	7.8	NA	990 a	NA	370	NA	µG/KG	µG/L	NO	NO	NO	NO
2,4,5-TP (Silvex)	NA	NA	120	NA	5600 a	NA	290	NA	µG/KG	µG/L	NO	NO	NO	NO
Organotin														
Tetrabutyltin	ND	5.5	ND	ND	NA	NA	11	NA	µG/KG	µG/L	NO	NO	NO	NO
Dioxin Compounds														
2,3,7,8-TCDD equivalents (TEQs) c	NA	NA	0.118	NA	1600 a	NA	0.45	10	NG/KG	PG/L	NO	NO	NO	NO
1234678-HpCDD c	NA	NA	6.36	NA	108000 a	NA	45	NA	NG/KG	PG/L	NO	NO	NO	NO
OCDD c	NA	NA	39.4	NA	1080000 a	NA	450	NA	NG/KG	PG/L	NO	NO	NO	NO
1234678-HpCDF c	NA	NA	1.25	NA	54000 a	NA	45	NA	NG/KG	PG/L	NO	NO	NO	NO
OCDF c	NA	NA	2.66	NA	540000 a	NA	450	NA	NG/KG	PG/L	NO	NO	NO	NO

Notes:
Sources of screening concentrations appear in Table 5.5.
Explanations of fate and transport screening procedures appear in Section 6.2.
Frequency and range of detections, average detected concentrations, and number of screening concentration exceedances appear in Tables 10.8.2, 10.8.6, and 10.8.10.

a - Calculated soil-to-groundwater SSL value (See Table 6.2)
b - Based on surrogate compound; see Table 5.5
c - Carcinogenic
GW - Groundwater

NA - Not applicable/not available
ND - Not detected
RBC - Risk-based concentration
SSL - Soil screening level

NG/KG - Nanograms per kilogram
µG/KG - Micrograms per kilogram
PG/L - Picograms per liter
µG/L - Micrograms per liter

Table 10.8.13
Inorganic Chemicals Detected in Surface Soil, Subsurface Soil, Sediment, and Shallow Groundwater
Comparison to Cross-Media SSLs, Tap-Water RBCs, Saltwater Surface Water Chronic Screening Levels, and Background Reference Values
AOC 687, SWMU 16
Charleston Naval Complex
Charleston, South Carolina

Parameter	Maximum Concentration Surface Soil	Subsurface Soil	Sediment	Shallow GW	Screening Concentration Soil to GW SSL	Soil Backgroun	Soil to Air SSL	Tap Water RBC	Shallow GW Background	Saltwater Surf. Wtr Chronic	Soil Units	Water Units	Leaching Potential	Fugitive Particulate Inhalation Concern	Ground-water Migration Concern	Surface Water Migration Concern
Inorganic Chemicals																
Aluminum (Al)	19300	27900	15000	1000	560000 a	27400	NA	37000	1440	NA	MG/KG	µG/L	NO	NO	NO	NO
Antimony (Sb)	ND	ND	0.77	ND	2.7	ND	NA	15	NA	NA	MG/KG	µG/L	NO	NO	NO	NO
Arsenic (As) c	12.4	19.8	11.9	131	15	21.6	750	0.045	23	36	MG/KG	µG/L	YES	NO	YES	YES
Barium (Ba)	26.5	33.9	33.3	49.3	820	54.2	690000	2600	110	NA	MG/KG	µG/L	NO	NO	NO	NO
Beryllium (Be)	0.89	1.2	0.6	0.4	32	0.95	1300	73	1.1	NA	MG/KG	µG/L	NO	NO	NO	NO
Chromium (Cr) (total)	40	50.1	40.3	26.1	19	51.3	270	180	14.3	50	MG/KG	µG/L	YES	NO	NO	NO
Cobalt (Co)	5.3	7.4	3.4	4.7	990 a	5.8	NA	2200	2.2	NA	MG/KG	µG/L	NO	NO	NO	NO
Copper (Cu)	19.1	25.8	52	29.3	5600 a	240	NA	1500	4.4	2.9	MG/KG	µG/L	NO	NO	NO	YES
Lead (Pb)	20.4	27.5	50.6	4	400	203	400	15	4.4	8.5	MG/KG	µG/L	NO	NO	NO	NO
Manganese (Mn)	482	355	203	3290	480 a	419	NA	730	5430	NA	MG/KG	µG/L	YES	NO	NO	NO
Mercury (Hg)	0.14	ND	ND	ND	1	0.47	10	11	NA	0.025	MG/KG	µG/L	NO	NO	NO	NO
Nickel (Ni)	12.5	13.8	16.5	24	65	23.9	13000	730	13.3	8.3	MG/KG	µG/L	NO	NO	NO	YES
Selenium (Se)	1.5	2	2.2	8.5	2.6	1.77	NA	180	ND	71	MG/KG	µG/L	NO	NO	NO	NO
Thallium (Tl)	ND	ND	ND	5.2	0.36	ND	NA	2.6	2	21.3	MG/KG	µG/L	NO	NO	YES	NO
Tin (Sn)	ND	ND	3.5	221	5500 a	7.5	NA	22000	NA	NA	MG/KG	µG/L	NO	NO	NO	NO
Vanadium (V)	42.6	72	ND	6.2	3000	113	NA	260	14	NA	MG/KG	µG/L	NO	NO	NO	NO
Zinc (Zn)	78.4	76.7	515	41.4	6200	206	NA	11000	24.4	86	MG/KG	µG/L	NO	NO	NO	NO

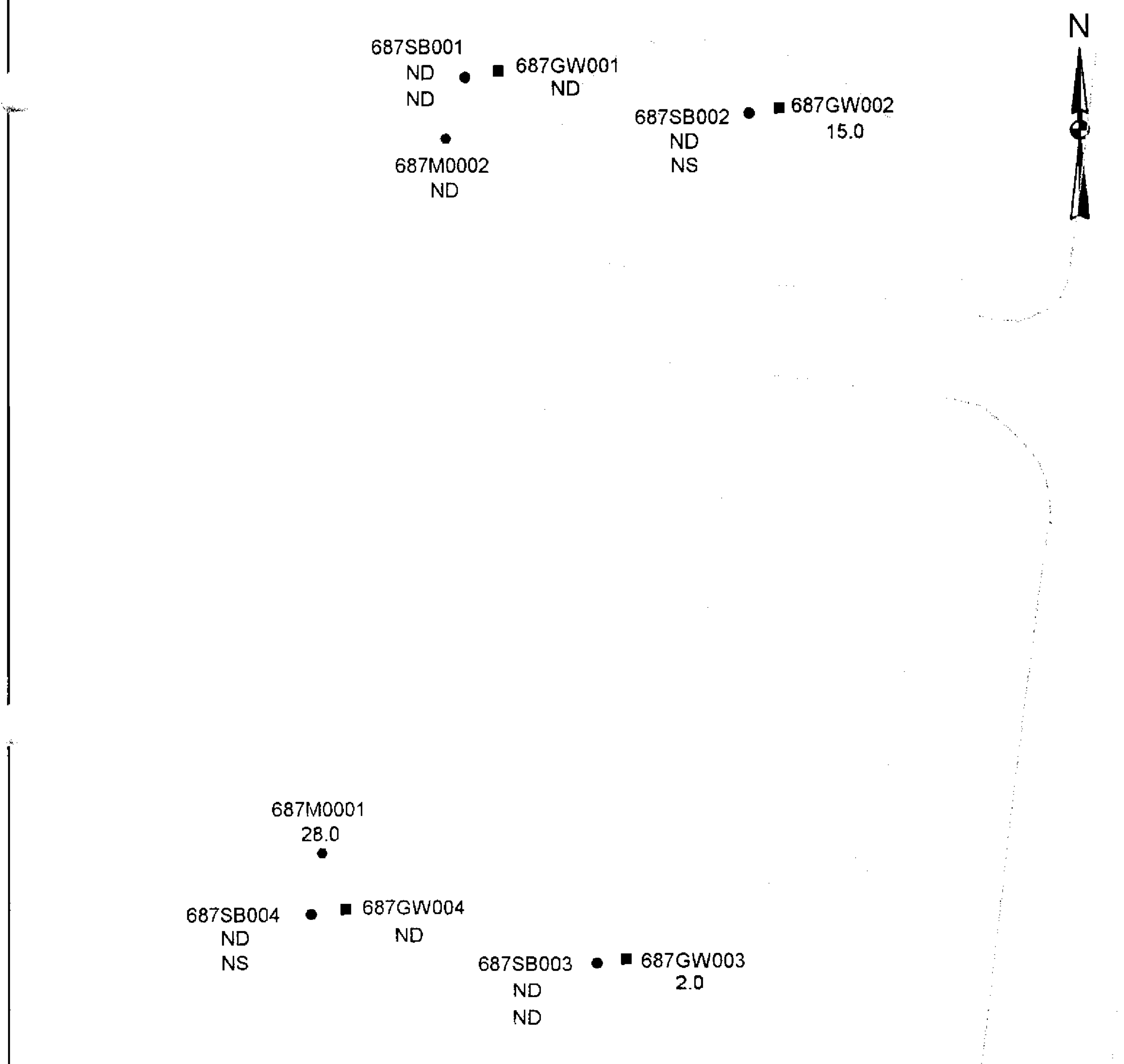
Notes:
Sources of screening concentrations appear in Table 5.6.
Explanations of fate and transport screening procedures appear in Section 6.2.
Frequency and range of detections, average detected concentrations, and number of screening concentration exceedances appear in Tables 10.8.3, 10.8.7, and 10.8.11.

Background values for soil are shown for comparison purposes only.
Maximum groundwater concentrations are screened against the greater of tap water RBCs or corresponding background values to determine groundwater migration concern.

a - Calculated soil-to-groundwater SSL value (See Table 6.2)
c - Carcinogenic
GW - Groundwater

NA - Not available/Not applicable
ND - Not detected
RBC - Risk-based concentration

SSL - Soil screening level
MG/KG - Milligrams per kilogram
µG/L - Micrograms per liter



LEGEND

●	ZONE I SEDIMENT SAMPLE LOCATION
■	MONITORING WELL LOCATION
●	ZONE I SOIL BORING LOCATION
12.30	ZONE I SURFACE SOIL CONC. (UG/KG)
12.30	ZONE I SUBSURFACE SOIL CONC. (UG/KG)
12.30	MAXIMUM QUARTERLY GW CONC. (UG/L)
NS	NO SAMPLE TAKEN
ND	NON DETECT

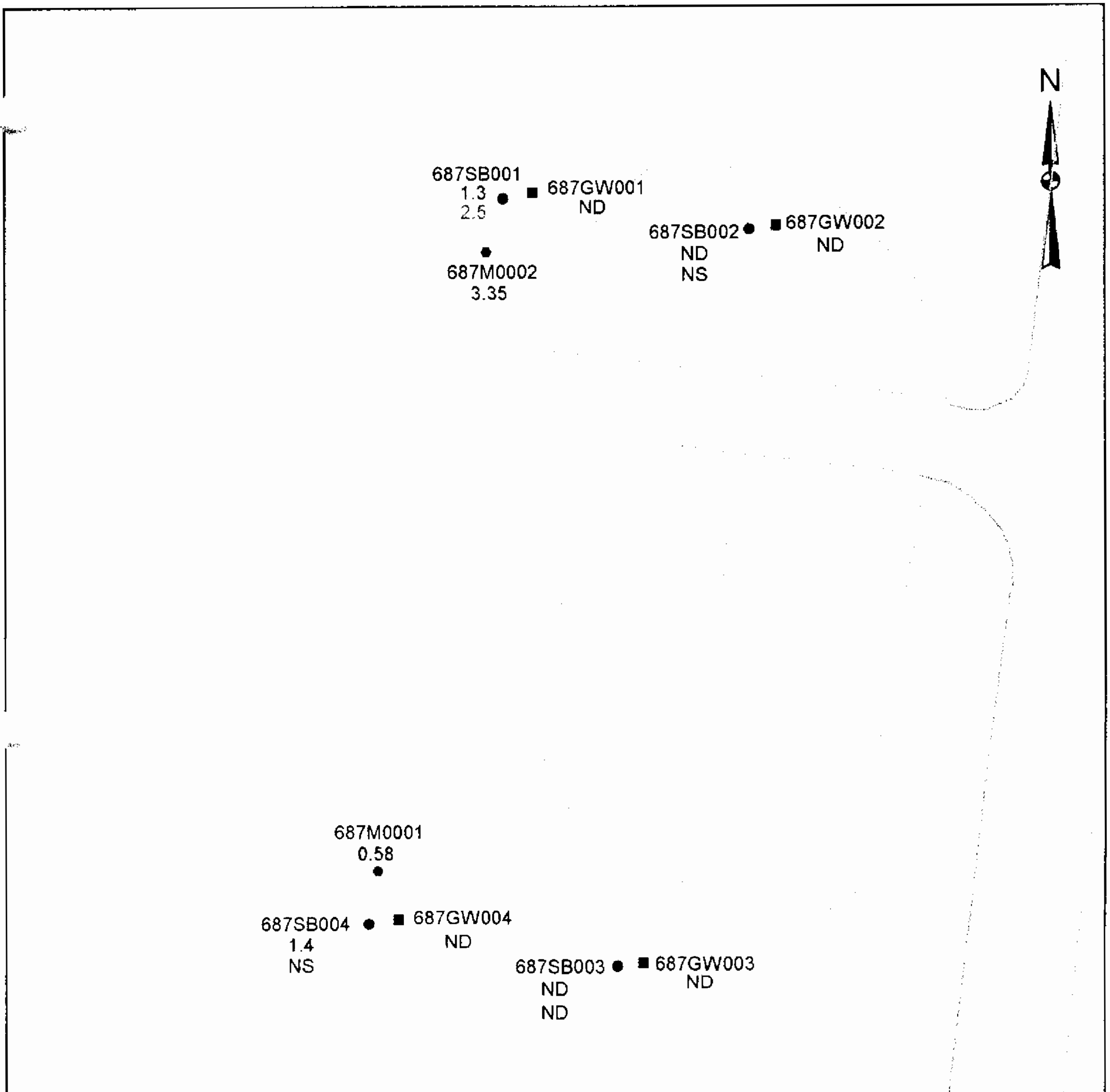
SCALE

20 0 20 40 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.8.2
ZONE I
AOC 687
METHYLENE CHLORIDE
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=NA RBC=85000 UG/KG SSL=10 UG/KG



LEGEND

●	ZONE I SEDIMENT SAMPLE LOCATION
■	MONITORING WELL LOCATION
●	ZONE I SOIL BORING LOCATION
12.30	ZONE I SURFACE SOIL CONC. (UG/KG)
12.30	ZONE I SUBSURFACE SOIL CONC. (UG/KG)
12.30	MAXIMUM QUARTERLY GW CONC. (UG/L)
NS	NO SAMPLE TAKEN
ND	NON DETECT

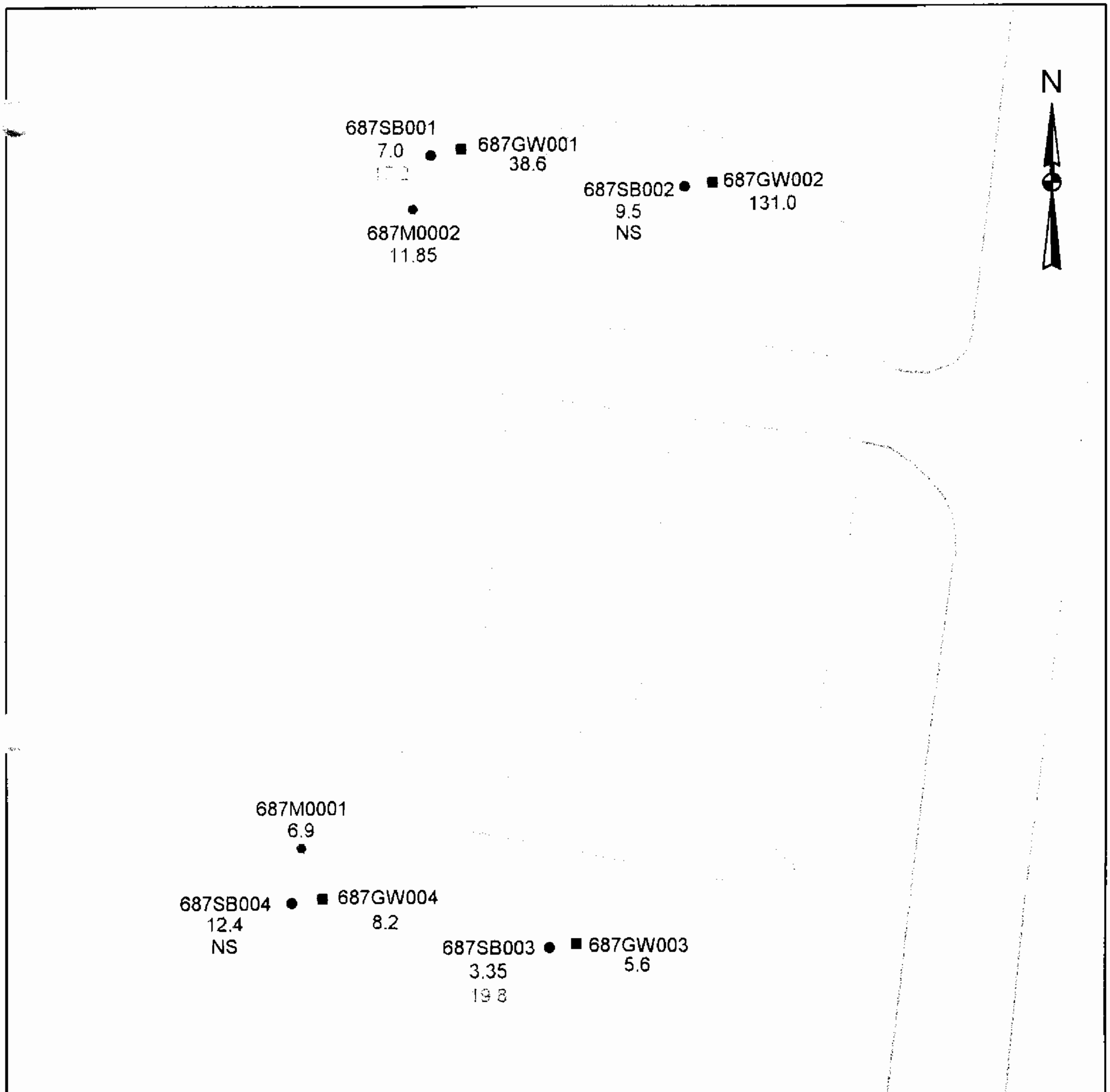
SCALE

20 0 20 40 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.8.3
ZONE I
AOC 687
BETA-BHC
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=NA RBC=350 UG/KG SSL=1.3 UG/KG



LEGEND

●	ZONE I SEDIMENT SAMPLE LOCATION
■	MONITORING WELL LOCATION
●	ZONE I SOIL BORING LOCATION
12.30	ZONE I SURFACE SOIL CONC. (MG/KG)
12.30	ZONE I SUBSURFACE SOIL CONC. (MG/KG)
12.30	MAXIMUM QUARTERLY GW CONC. (UG/L)
NS	NO SAMPLE TAKEN
ND	NON DETECT

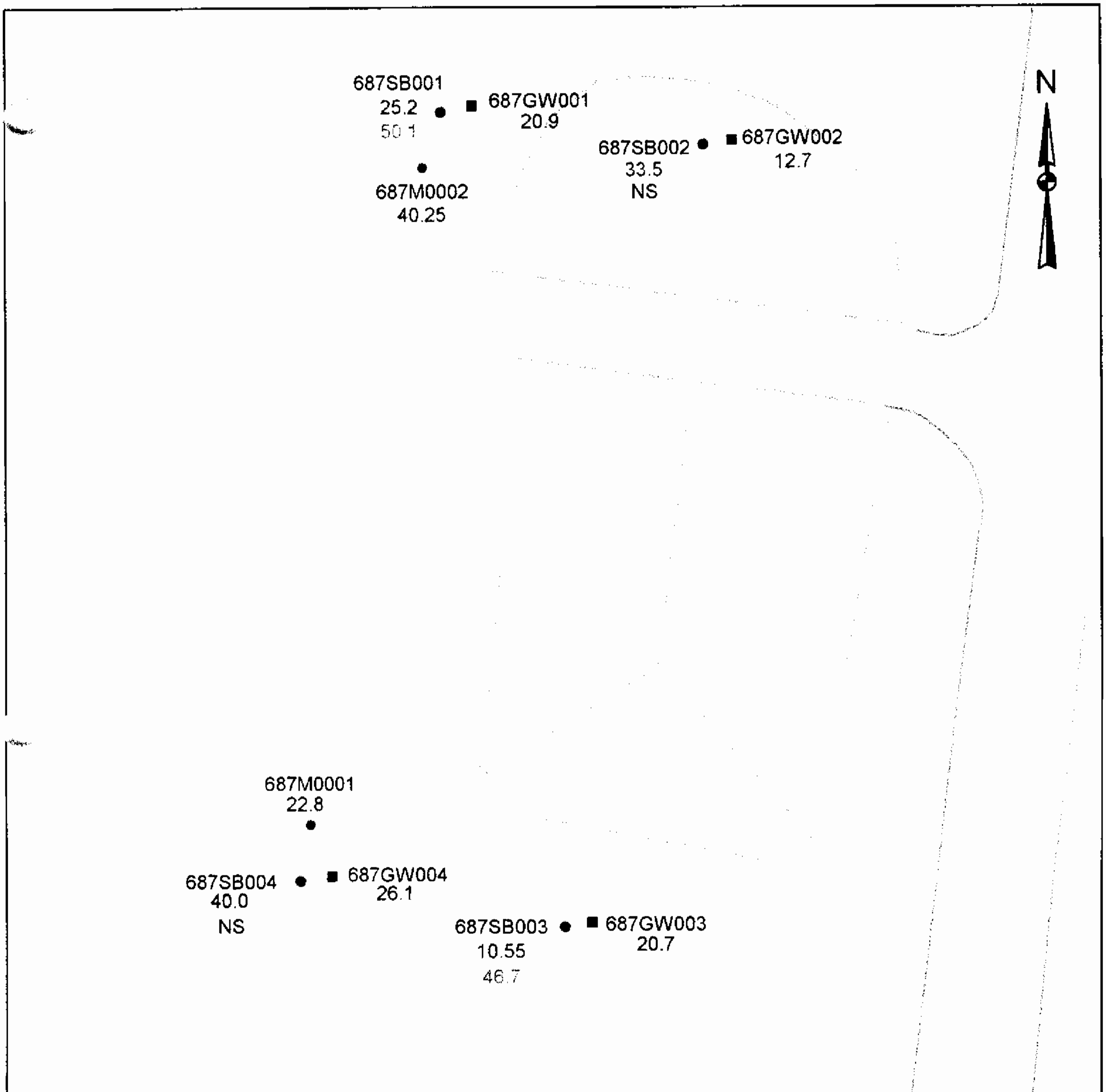
SCALE

20 0 20 40 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.8.4
ZONE I
AOC 687
ARSENIC
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=50 UG/L RBC=.43 MG/KG SSL=15 MG/KG



LEGEND

●	ZONE I SEDIMENT SAMPLE LOCATION
■	MONITORING WELL LOCATION
●	ZONE I SOIL BORING LOCATION
12.30	ZONE I SURFACE SOIL CONC. (MG/KG)
12.30	ZONE I SUBSURFACE SOIL CONC. (MG/KG)
12.30	MAXIMUM QUARTERLY GW CONC. (UG/L)
NS	NO SAMPLE TAKEN
ND	NON DETECT

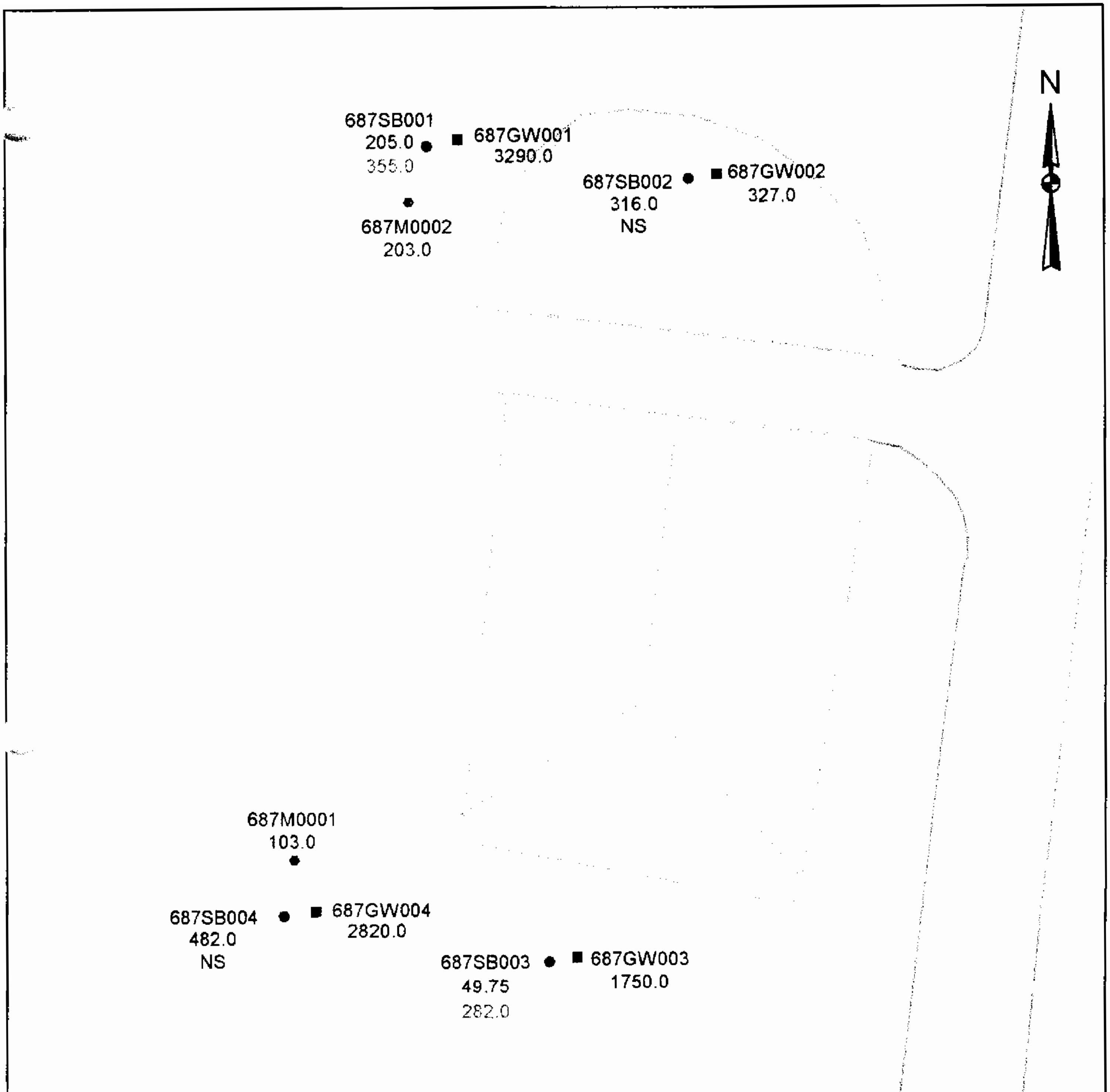
SCALE

20 0 20 40 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.8.5
ZONE I
AOC 687
CHROMIUM
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=100 UG/L RBC=39 MG/KG SSL=19 MG/KG



LEGEND

●	ZONE I SEDIMENT SAMPLE LOCATION
■	MONITORING WELL LOCATION
●	ZONE I SOIL BORING LOCATION
12.30	ZONE I SURFACE SOIL CONC. (MG/KG)
12.30	ZONE I SUBSURFACE SOIL CONC. (MG/KG)
12.30	MAXIMUM QUARTERLY GW CONC. (UG/L)
NS	NO SAMPLE TAKEN
ND	NON DETECT

SCALE

20 0 20 40 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.8.6
ZONE I
AOC 687
MANGANESE
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=NA RBC=160 MG/KG SSL=480 MG/KG

10.8.7.2 Groundwater Migration and Surface Water Cross-Media Transport

Tables 10.8.12 and 10.8.13 compare maximum detected organic and inorganic constituent concentrations respectively in shallow groundwater samples to risk-based concentrations for drinking water, and to chronic ambient saltwater quality criteria values for the protection of aquatic life (saltwater surface water chronic screening values). For inorganics, maximum concentrations in groundwater are screened against the greater of: (a) risk-based drinking water concentrations or (b) corresponding background reference concentrations for groundwater, and to the saltwater surface water chronic values. To provide a conservative screening, no attenuation or dilution of constituents in groundwater is assumed before comparison to the relevant standards. It should be noted that the risk-based pathway for shallow groundwater is currently an invalid pathway simply because there is no human consumption of the groundwater, e.g., there is no end-use receptor. This comparison is made for screening only, and to develop strategies for long-term management of the groundwater if an area containing deleterious levels is identified.

One organic constituent was present at concentrations that exceeded its RBC (Figure 10.8.2). Methylene chloride was detected in two of four samples during the first-round of sampling, but has been nondetect since. The only other VOC in groundwater – acetone – had a similar detection history. These data suggest that methylene chloride and arsenic may be relics of the drilling process (carry-down). At the very least, the absence of methylene chloride in subsequent sampling invalidates the risk-based pathway for that constituent.

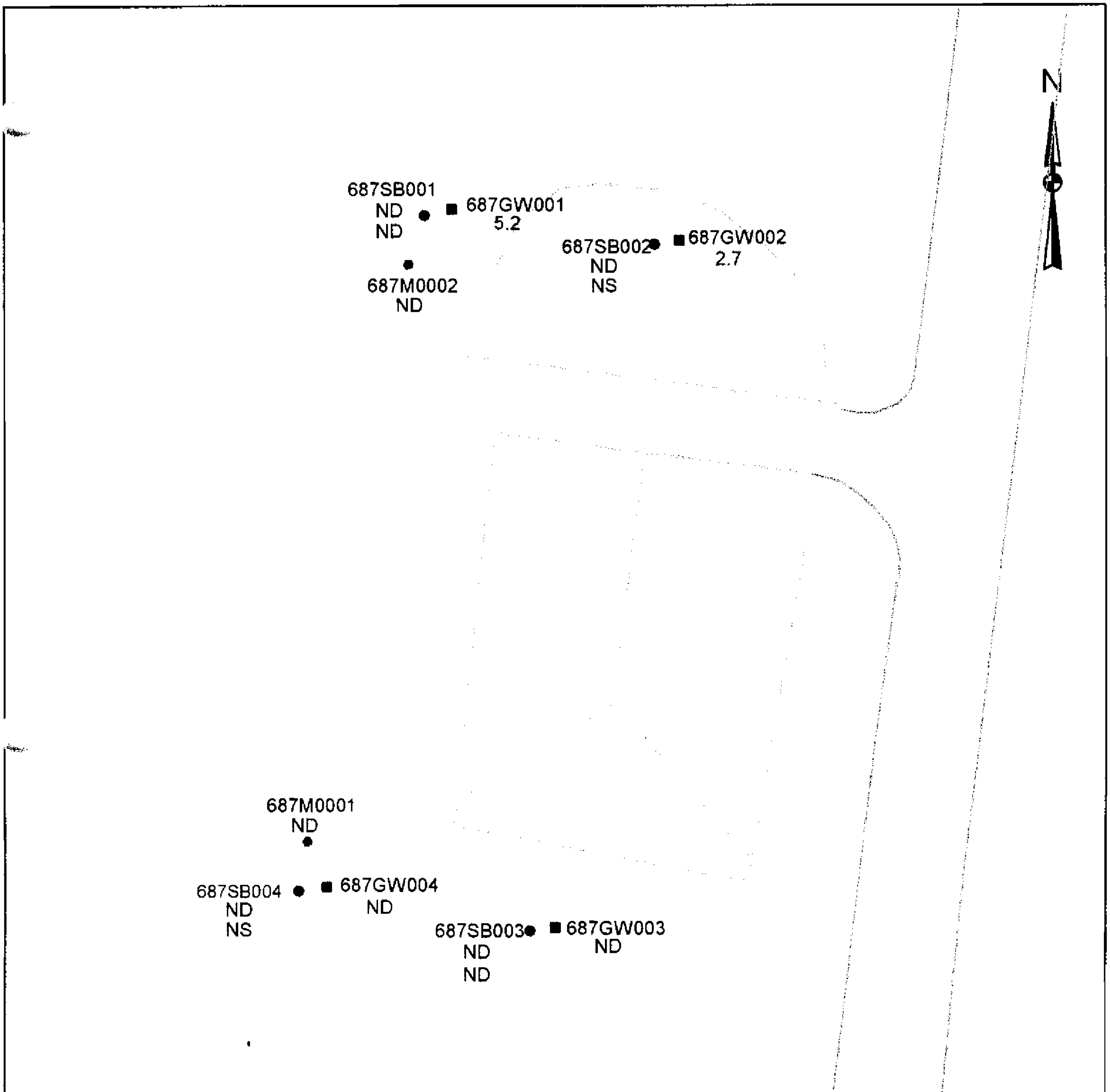
Two inorganics were detected at concentrations that exceeded their respective RBCs. Arsenic was detected in three of four samples in the first and fifth sampling rounds. All concentrations were greater than the zone-specific background and significantly above the RBC. The wide occurrence of arsenic indicates a notable residual mass to be considered in further analysis. Thallium was nondetect in site soil, and was detected in two of four samples during the fourth sampling round, but slightly exceeded the RBC. Figure 10.8.7 presents thallium concentrations detected at

AOC 687/SWMU 16. Thallium has been intermittently detected in zone media, and, as a result, the source is unknown, but not likely to be associated with any particular site. Rather, the data indicate that it is associated with either native lithology or is a constituent of non-native fill. The pathway for thallium is valid chemically, but the significance is questionable due to the inconsistent detections and the low concentrations.

Copper and nickel were detected in groundwater at concentrations that exceeded their respective surface water screening values. Copper was only exceeded in one of four samples during sixth sampling round of sampling; detections over the last year have been sporadic, but have still exceeded the surface water screening level. Figure 10.8.8 presents copper concentrations detected at AOC 687/SWMU 16. Nickel was detected in only one of four samples during the last round of sampling; detections have decreased in number over the four rounds of sampling, but detected concentrations have varied. Figure 10.8.9 presents nickel concentrations detected at AOC 687/SWMU 16. Both parameters were detected in site soil, but are unlikely to be residual from site activities. The Cooper River is immediately adjacent to this AOC, and groundwater flow is consistent with a discharge to the river. Therefore, the pathway is considered chemically valid, but further analysis should incorporate collection of empirical data from the surface water`samples, as well as quantification of dispersion along the flowpath and dilution upon discharge.

10.8.7.3 Soil-to-Sediment Cross-Media Transport

Tables 10.8.12 and 10.8.13 summarize parameters detected and their maximum concentrations in site sediment. Sediment was sampled from a drainage ditch east of the site specially to characterize potential contamination entrained in surface water runoff from the site.



LEGEND

●	ZONE I SEDIMENT SAMPLE LOCATION
■	MONITORING WELL LOCATION
●	ZONE I SOIL BORING LOCATION
12.30	ZONE I SURFACE SOIL CONC. (MG/KG)
12.30	ZONE I SUBSURFACE SOIL CONC. (MG/KG)
12.30	MAXIMUM QUARTERLY GW CONC. (UG/L)
NS	NO SAMPLE TAKEN
ND	NON DETECT

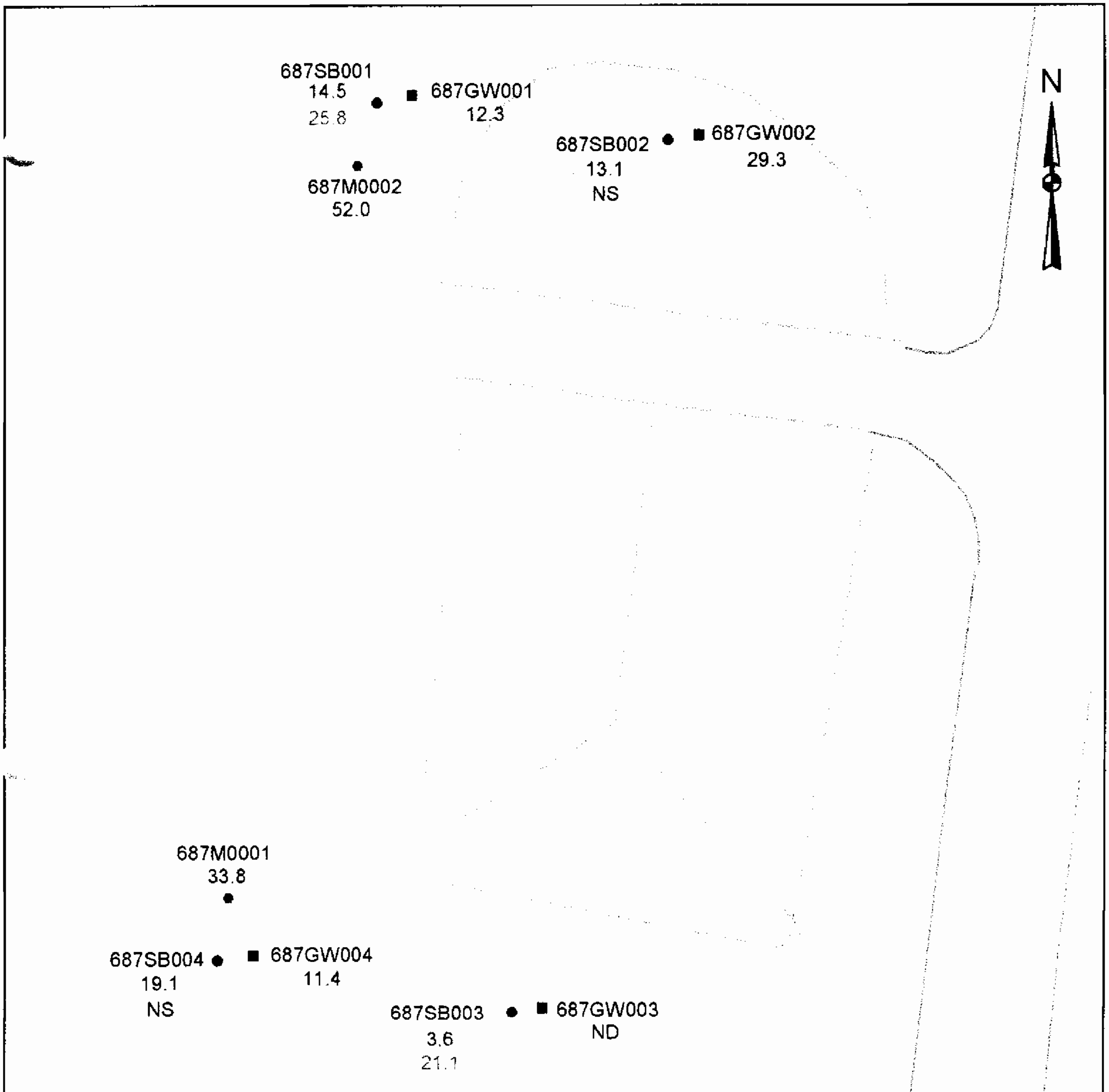
SCALE

20 0 20 40 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.8.7
ZONE I
AOC 687
THALLIUM
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=2 UG/L RBC=.55 MG/KG SSL=.36 MG/KG



LEGEND

●	ZONE I SEDIMENT SAMPLE LOCATION
■	MONITORING WELL LOCATION
●	ZONE I SOIL BORING LOCATION
12.30	ZONE I SURFACE SOIL CONC. (MG/KG)
12.30	ZONE I SUBSURFACE SOIL CONC. (MG/KG)
12.30	MAXIMUM QUARTERLY GW CONC. (UG/L)
NS	NO SAMPLE TAKEN
ND	NON DETECT

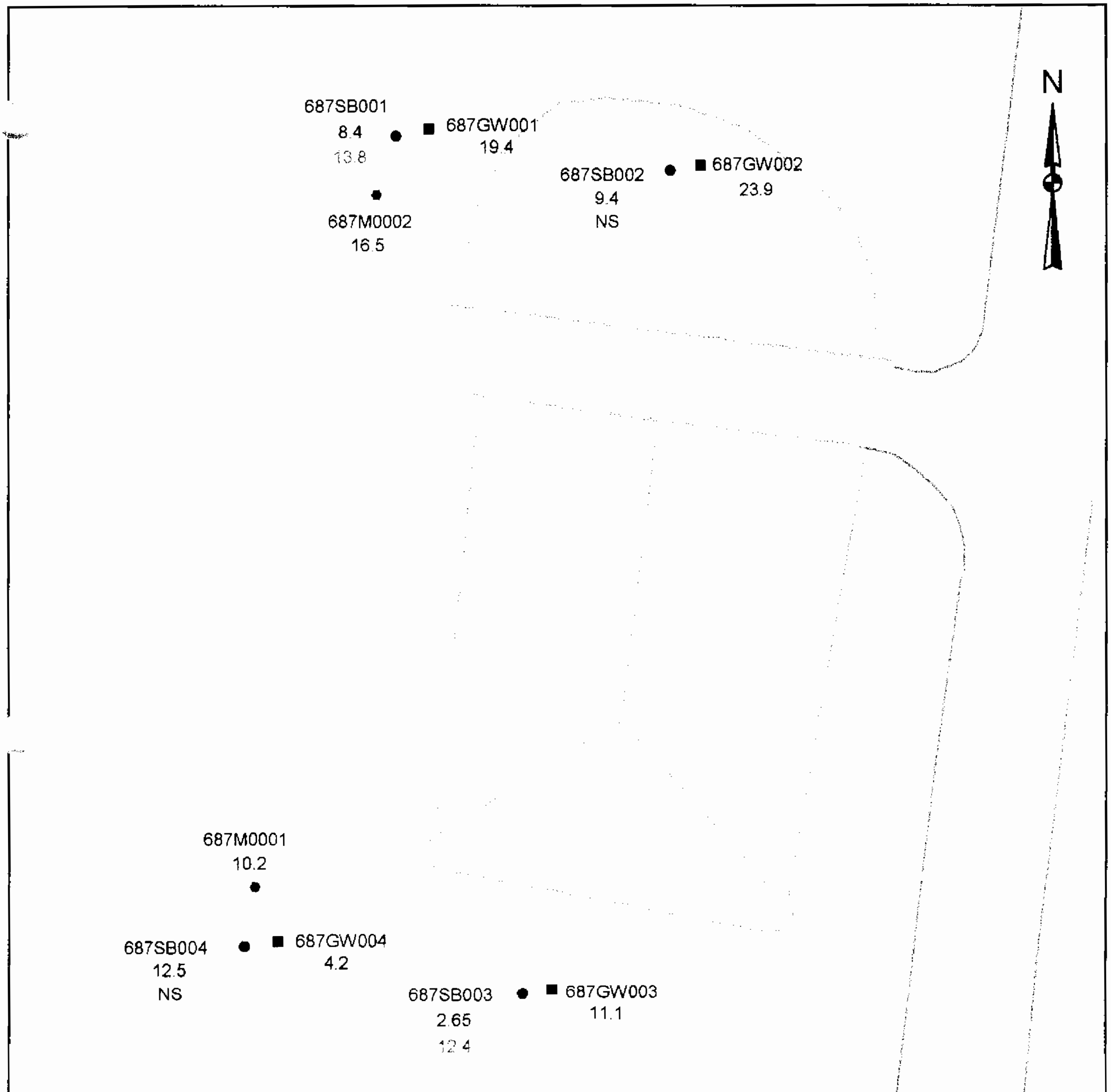
SCALE

20 0 20 40 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.8.8
ZONE I
AOC 687
COPPER
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=1300 UG/L RBC=310 MG/KG SSL=5600 MG/KG



LEGEND

- ● ZONE I SEDIMENT SAMPLE LOCATION
- ■ MONITORING WELL LOCATION
- ● ZONE I SOIL BORING LOCATION
- 12.30 ZONE I SURFACE SOIL CONC. (MG/KG)
- 12.30 ZONE I SUBSURFACE SOIL CONC. (MG/KG)
- *12.30* MAXIMUM QUARTERLY GW CONC. (UG/L)
- NS NO SAMPLE TAKEN
- ND NON DETECT

SCALE

20 0 20 40 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.8.9
ZONE I
AOC 687
NICKEL
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=100 UG/L RBC=160 MG/KG SSL=65 MG/KG

Several semivolatile and pesticide/herbicide compounds detected in sediment were not present in site surface soil. Their occurrence is not unexpected, given the site setting. The drainage ditch area receives runoff from the adjacent access road, which is likely laden with semivolatiles, and the ditch area is likely to have received pesticides and herbicides from routine application over the years. The absence of these constituents in site surface soil clearly eliminates the site as their source.

Most inorganic parameters detected in sediment are similar in nature and concentration to those present in surface soil. The similarity in the data suggests that the site could have been their source, or that the sediment in the ditch is really periodically inundated surface soil.

10.8.7.4 Soil-to-Air Transport

Two VOCs were detected in site surface soil: acetone and methylene chloride. However, all concentrations were far below their soil-to-air SSL, thus, the pathway is not expected to be significant for this site.

10.8.7.5 Fate and Transport Summary

Soil-to-Groundwater Pathway

Two organics were detected at concentrations above their SSL: methylene chloride and beta-BHC.

- Methylene chloride was present in only one of four surface samples, and was nondetect in subsurface soil. Although it was nondetect in subsurface soil, the additional presence of acetone in soil and both of these organics in groundwater suggests that the soil-to-groundwater pathway has merit.

- Beta-BHC was present in only one surface and one subsurface soil sample at a concentration slightly exceeding its SSL. The low concentrations and limited lateral persistence suggest that the pathway is not significant, although it is valid. The pathway's lack of significance is substantiated by its absence in groundwater.

Inorganics

Three inorganics were present in soil at levels that exceeded their SSLs: arsenic, chromium, and manganese.

- Arsenic and chromium were widely detected, but were below the zone-specific backgrounds in all samples.

- Manganese, also widely detected, was below background in all subsurface samples.

- All three inorganics are commonly detected in Zone I soil. The presence of both arsenic and chromium at concentrations exceeding SSLs in subsurface soil validates the soil-to-groundwater pathway for both, while the absence of manganese in subsurface soil suggests that site soil may be not be a significant source of manganese flux to groundwater. However, the background concentration of each constituent should be the point of departure for risk management.

Groundwater Ingestion and Migration to Surface Water Pathways

Organics

Only one organic parameter was detected at a concentration exceeding its RBC: methylene chloride.

- This parameter was detected in two of four samples in the first-round, but has been absent since. Acetone was the only other organic parameter in groundwater, and its detection history was similar. These data suggest that their presence may well be a relic of the drilling process, and their absence since the first-round invalidates the ingestion pathway for both.

Inorganics

Two inorganics were present at levels that exceeded their RBCs: arsenic and thallium. Copper and nickel were detected at concentrations exceeding their surface water screening values.

- Arsenic was present in three of four samples, and has exceeded the zone-specific background in most samples. The data suggest that most of the groundwater mass underlying the site should be considered in risk management with respect to this parameter.

- Thallium was present in two samples during the fourth sampling round only. It has been intermittently detected at low concentrations at Zone I, and its presence does not seem to be associated with any particular site. The pathway for thallium is valid chemically, but the significance is in question due to the inconsistent detections and the low concentrations.

- Copper has been intermittently detected over the last sampling rounds, at concentrations generally greater than the surface water screening values. The frequency of nickel detections has decreased over the last sampling rounds, but the concentrations have varied.

- The Cooper River is immediately adjacent to the site, and the flowpath direction is consistent with a discharge to the river. Therefore, this pathway is considered valid and further analysis should incorporate collection of empirical data from the river along the discharge boundary, as well as quantification of dispersion along the flowpath and dilution at the discharge point.

Soil-to-Sediment Pathway

Organics

A significant number of organics – semivolatiles and pesticides/herbicides – were detected in sediment, but not in site surface soil.

- Both groups of chemicals are likely the result of runoff and routine application along the access road adjacent to the site. Their absence in site soil clearly eliminates the site as a source.

Inorganics

The inorganics detected in sediment were similar in concentration to those in surface soil.

- These parameters may be from the site runoff, or they may be present simply because the sediment is really periodically inundated surface soil.

Soil-to-Air Pathway

Two VOCs were detected in surface soil, but none exceeded the soil-to-air SSL, thus indicating the pathway is not significant.

10.8.8 Human Health Risk Assessment

10.8.8.1 Site Background and Investigative Approach

AOC 687 consists of Building X-55, an earth covered ammunition storage bunker constructed in 1942. The concrete walls and ceiling of the bunker are 4 feet thick. The entire structure is covered by 2 feet of soil. Surrounding the bunker, is a cement and soil containment berm designed to control the bunker door in the event of an explosion. The storage bunker is approximately 29 feet wide, 52 feet long, and 12 feet high. The area is surrounded by a chain-link fence. The AOC is located between Juneau Avenue and the Dredged Materials Area (DMA). The Cooper River and associated wetlands are to the east of the site across Juneau Avenue.

The bunker appears to have been used for ammunition storage since its construction in 1942. No other uses are known. At the time of the RFA, explosives and small arms ammunition were stored in the bunker. The magazine is currently empty, although no information is available regarding the dates of explosive/ammunition removal.

SWMU 16 (the earthen roof of Building X-55) has been associated with AOC 687 due to prior unauthorized storage of potentially hazardous material (empty paint containers). This paint container storage was identified as a one time occurrence and is not thought to represent a historical problem. Minor spills associated with the storage of the paint containers were cleaned and the paint containers themselves were removed from the site at the time of discovery.

Soil was sampled in one round at the combined sites from the locations previously shown on Figure 10.8.1. Soil samples were collected from the four monitoring well borings advanced around the combined sites' perimeter. Samples were submitted for the standard suite of parameters (VOCs, SVOCs, metals, cyanide, pesticides, and PCBs) and organotins at DQO Level III. One upper-interval duplicate sample was analyzed for the standard suite of parameters, plus organotins at DQO Level IV. Two sediment samples were collected from the surface interval. These two samples, 687M0001 and 687M0002, were collected from a drainage ditch immediately east of the site to characterize potential contamination from surface water runoff within the site area. The two sediment samples collected were analyzed for organotins and the standard suite (VOCs, SVOCs, metals, cyanide, pesticides and PCBs) at DQO Level III. They were also analyzed for TOC and grain size. One duplicate sample was analyzed for Appendix IX analysis at DQO Level IV.

Four shallow groundwater monitoring wells were installed and sampled as part of the RFI at these combined sites. Groundwater was sampled in six-rounds at the combined sites. During the first sampling round, wells were sampled for the standard suite of parameters, organotins, chloride, TDS, and sulfate at DQO Level III. Samples from rounds two and three were analyzed for cyanide, and metals (6870004 was also sampled for chloride, sulfate, and TDS). Fourth-round samples were analyzed for chloride, cyanide, sulfate, metals, pesticides, PCBs, VOCs and TDS. Fifth-round samples were analyzed for metals and VOCs. Sixth-round samples were analyzed for metals, SVOCs and VOCs. Figure 10.8.2, shown previously, illustrates monitoring well locations.

10.8.8.2 COPC Identification

Surface Soil/Sediment

Based on the screening comparisons described in Section 7 of this RFI and presented in Tables 10.8.14 and 10.8.15, the focus of this HHRA is on the following COPCs: benzo(a)pyrene equivalents, chlordane, chromium, and manganese. Residential soil RBCs and background concentrations were used in the sediment screening process. Aluminum and arsenic's maximum concentrations exceeded their RBCs; however, they did not exceed their background concentration. The results of Wilcoxon rank sum test analyses did not result in the inclusion of any inorganic parameters which had been screened out on the basis of background concentration comparisons.

Groundwater

Based on the screening comparisons described in Section 7 of this RFI and presented in Table 10.8.16, this HHRA focuses on the following COPCs: arsenic, chromium, thallium, and methylene chloride. Manganese's maximum concentration exceeded its RBC but not its background concentration. The Wilcoxon rank sum test analyses did not result in the inclusion of any parameter as a groundwater COPC.

Table 10.8.14
Chemicals Present in Site Samples
SWMU 16 and AOC 687 - Surface Soil
Charleston Naval Complex
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration Residential RBC	Background	Units	Number Exceeding RBC	Background
Inorganics													
Aluminum (Al)		4	4	4565	19300	11994	NA	NA	7800	27400	MG/KG	3	
Arsenic (As)		4	4	3.35	12.4	8.06	NA	NA	0.43	21.6	MG/KG	4	
Barium (Ba)		4	4	13.9	26.5	18.9	NA	NA	550	54.2	MG/KG		
Beryllium (Be)		3	4	0.45	0.89	0.67	0.23	0.23	16	0.95	MG/KG		
Calcium (Ca)	N	4	4	3260	33000	16414	NA	NA	NA	NA	MG/KG		
Chromium (Cr)	*	4	4	10.6	40	27.3	NA	NA	39	34.5	MG/KG	1	1
Cobalt (Co)		4	4	0.895	5.3	3.22	NA	NA	470	5.8	MG/KG		
Copper (Cu)		4	4	3.6	19.1	12.6	NA	NA	310	240	MG/KG		
Iron (Fe)	N	4	4	6980	22100	14345	NA	NA	NA	NA	MG/KG		
Lead (Pb)		4	4	11	20.4	15.9	NA	NA	400	203	MG/KG		
Magnesium (Mg)	N	4	4	487	3260	2027	NA	NA	NA	NA	MG/KG		
Manganese (Mn)	*	4	4	49.8	482	263	NA	NA	160	419	MG/KG	3	1
Mercury (Hg)		1	4	0.14	0.14	0.14	0.11	0.13	2.3	0.47	MG/KG		
Nickel (Ni)		4	4	2.65	12.5	8.24	NA	NA	160	23.9	MG/KG		
Potassium (K)	N	4	4	343	1780	1168	NA	NA	NA	NA	MG/KG		
Selenium (Se)		4	4	0.76	1.5	1.13	NA	NA	39	1.49	MG/KG		1
Sodium (Na)	N	1	4	364	364	364	149	306	NA	NA	MG/KG		
Vanadium (V)		4	4	15.9	42.6	27.7	NA	NA	55	113	MG/KG		
Zinc (Zn)		4	4	18.9	78.4	49.8	NA	NA	2300	206	MG/KG		
Pesticides/PCBs													
Aroclor-1260		2	4	27	35	31	22	24	320	NA	µG/KG		
beta-BHC		2	4	1.3	1.4	1.35	1.1	1.2	350	NA	µG/KG		
Volatile Organics													
Acetone		2	4	8	8.5	8.25	110	110	780000	NA	µG/KG		
Methylene chloride		1	4	28	28	28	22	27	85000	NA	µG/KG		

Notes:
* - Indicates chemical was identified as a COPC
N - Indicates chemical is an essential nutrient
SQL - Sample quantitation limit
RBC - Risk-based concentration
µG/KG - micrograms per kilogram
MG/KG - milligrams per kilogram
NA - Not applicable or not available

Table 10.8.15
Chemicals Present in Site Samples
SWMU 16 and AOC 687 - Sediment
Charleston Naval Complex
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration Residential RBC	Screening Concentration Background	Units	Number Exceeding RBC	Number Exceeding Background
Carcinogenic PAHs													
Benzo(a)pyrene Equivalents	*	1	2	1305	1305	1305	1500	1500	87	NA	µG/KG	1	
Benzo(a)anthracene		1	2	580	580	580	770	770	870	NA	µG/KG		
Benzo(a)pyrene	*	1	2	790	790	790	770	770	87	NA	µG/KG	1	
Benzo(b)fluoranthene	*	1	2	2650	2650	2650	900	900	870	NA	µG/KG	1	
Benzo(k)fluoranthene		1	2	2950	2950	2950	730	730	8700	NA	µG/KG		
Chrysene		1	2	1650	1650	1650	630	630	87000	NA	µG/KG		
Dibenz(a,h)anthracene	*	1	2	120	120	120	500	500	87	NA	µG/KG	1	
Indeno(1,2,3-cd)pyrene		1	2	405	405	405	540	540	870	NA	µG/KG		
Inorganics													
Aluminum (Al)		2	2	8420	14950	11685	NA	NA	7800	27400	MG/KG	2	
Antimony (Sb)		2	2	0.58	0.77	0.68	NA	NA	3.1	ND	MG/KG		
Arsenic (As)		2	2	6.9	11.85	9.38	NA	NA	0.43	21.6	MG/KG	2	
Barium (Ba)		2	2	19.3	33.3	26.3	NA	NA	550	54.2	MG/KG		
Beryllium (Be)		1	2	0.6	0.6	0.6	0.37	0.37	16	0.95	MG/KG		
Calcium (Ca)		2	2	29200	52100	40650	NA	NA	NA	NA	MG/KG		
Chromium (Cr)	*	2	2	22.8	40.3	31.5	NA	NA	39	34.5	MG/KG	1	1
Cobalt (Co)		2	2	2	3.35	2.68	NA	NA	470	5.8	MG/KG		
Copper (Cu)		2	2	33.8	52	42.9	NA	NA	310	240	MG/KG		
Iron (Fe)		2	2	8510	13900	11205	NA	NA	NA	NA	MG/KG		
Lead (Pb)		2	2	30.6	50.6	40.6	NA	NA	400	203	MG/KG		
Magnesium (Mg)		2	2	1820	3910	2865	NA	NA	NA	NA	MG/KG		
Manganese (Mn)		2	2	103	203	153	NA	NA	160	419	MG/KG	1	
Nickel (Ni)		2	2	10.2	16.5	13.35	NA	NA	160	23.9	MG/KG		
Potassium (K)		2	2	894	1560	1227	NA	NA	NA	NA	MG/KG		
Selenium (Se)		2	2	1.5	2.2	1.85	NA	NA	39	1.49	MG/KG		2
Sodium (Na)		2	2	717	1125	921	NA	NA	NA	NA	MG/KG		
Tin (Sn)		2	2	2.6	3.45	3.03	NA	NA	4700	7.5	MG/KG		
Zinc (Zn)		2	2	289	515	402	NA	NA	2300	206	MG/KG		2

Table 10.8.15
Chemicals Present in Site Samples
SWMU 16 and AOC 687 - Sediment
Charleston Naval Complex
Charleston, South Carolina

Parameter	Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration Residential RBC	Background	Units	Number Exceeding RBC	Background
Pesticides												
4,4'-DDD	1	2	20.5	20.5	20.5	2	2	2700	NA	µG/KG		
4,4'-DDE	2	2	3.3	129	65.9	NA	NA	1900	NA	µG/KG		
4,4'-DDT	2	2	1.1	6.85	3.98	NA	NA	1900	NA	µG/KG		
Aldrin	2	2	0.057	1.25	0.65	NA	NA	38	NA	µG/KG		
beta-BHC	1	2	3.35	3.35	3.35	0.58	0.58	350	NA	µG/KG		
Chlordane *	1	2	5250	5250	5250	2.3	2.3	1800	NA	µG/KG	1	
delta-BHC	2	2	0.83	1.55	1.19	NA	NA	350	NA	µG/KG		
Dieldrin	2	2	1.9	2.04	1.97	NA	NA	40	NA	µG/KG		
Endosulfan I	1	2	1.4	1.4	1.4	6.6	6.6	47000	NA	µG/KG		
Endosulfan II	2	2	0.96	3	1.98	NA	NA	47000	NA	µG/KG		
Endosulfan sulfate	1	2	2.8	2.8	2.8	1.2	1.2	47000	NA	µG/KG		
Endrin	2	2	0.96	8.4	4.68	NA	NA	2300	NA	µG/KG		
Endrin aldehyde	2	2	1.2	57	29.1	NA	NA	2300	NA	µG/KG		
Heptachlor	1	2	2.95	2.95	2.95	0.58	0.58	140	NA	µG/KG		
Heptachlor epoxide	1	2	36.7	36.7	36.7	0.58	0.58	70	NA	µG/KG		
Methoxychlor	2	2	2	8.7	5.35	NA	NA	39000	NA	µG/KG		
Organophosphate Pesticides												
Dimethoate	1	2	36	36	36	770	770	1600	NA	µG/KG		
Parathion	1	1	9.6	9.6	9.6	NA	NA	47000	NA	µG/KG		
Semivolatile Organics												
1-Methyl naphthalene	1	2	80	80	80	1300	1300	310000	NA	µG/KG		
Acenaphthylene	1	2	63	63	63	790	790	310000	NA	µG/KG		
Anthracene	1	2	94.5	94.5	94.5	870	870	2300000	NA	µG/KG		
Benzo(g,h,i)perylene	1	2	405	405	405	730	730	310000	NA	µG/KG		
bis(2-Ethylhexyl)phthalate (BEHP)	2	2	180	250	215	NA	NA	46000	NA	µG/KG		
Fluoranthene	2	2	49	2100	1075	NA	NA	310000	NA	µG/KG		
Phenanthrene	1	2	225	225	225	730	730	230000	NA	µG/KG		
Pyrene	2	2	38	1650	844	NA	NA	230000	NA	µG/KG		

Table 10.8.15
Chemicals Present in Site Samples
SWMU 16 and AOC 687 - Sediment
Charleston Naval Complex
Charleston, South Carolina

Parameter	Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration Residential RBC	Screening Concentration Background	Units	Number Exceeding RBC	Number Exceeding Background
Herbicides												
2,4,5-T	1	1	7.8	7.8	7.8	NA	NA	78000	NA	µG/KG		
2,4,5-TP (Silvex)	1	1	120	120	120	NA	NA	63000	NA	µG/KG		
TCDD Equivalents												
Dioxin (TCDD Equivalents)	1	1	0.118	0.118	0.118	NA	NA	4.3	NA	NG/KG		
1234678-HpCDD	1	1	6.36	6.36	6.36	NA	NA	NA	NA	NG/KG		
1234678-HpCDF	1	1	1.25	1.25	1.25	NA	NA	NA	NA	NG/KG		
OCDD	1	1	39.4	39.4	39.4	NA	NA	NA	NA	NG/KG		
OCDF	1	1	2.66	2.66	2.66	NA	NA	NA	NA	NG/KG		

Notes:
* - Indicates chemical was identified as a COPC
SQL - Sample quantitation limit
RBC - Risk-based concentration
µG/KG - micrograms per kilogram
MG/KG - milligrams per kilogram
NG/KG - nanograms per kilogram
NA - Not applicable or not available
ND - Not determined due to lack of information

Table 10.8.16
Chemicals Present in Site Samples
SWMU 16 and AOC 687 - Groundwater
Charleston Naval Complex
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration Tap Water RBC	Background	Units	Number Exceeding RBC	Background
Inorganics													
Aluminum (Al)		4	24	209	1000	455	18	65.7	3700	1440	µG/L		
Arsenic (As)	*	13	24	3.3	131	31.5	2.5	5	0.045	23	µG/L	13	6
Barium (Ba)		15	24	13	49.3	23	5	34.8	260	110	µG/L		
Beryllium (Be)		4	24	0.33	0.4	0.4	0.2	1	7.3	1.1	µG/L		
Calcium (Ca)		24	24	164000	449000	238875	NA	NA	NA	NA	µG/L		
Chromium (Cr)	*	8	24	1.5	26.1	11.3	0.87	2.2	18	14.3	µG/L	3	3
Cobalt (Co)		3	24	1.3	3.1	2.1	0.6	5	220	2.2	µG/L		1
Copper (Cu)		4	24	2.1	29.3	13.8	0.7	16.9	150	4.4	µG/L		3
Iron (Fe)		21	24	211	13700	3454	20	112	NA	NA	µG/L		
Lead (Pb)		3	24	2.1	4	2.9	1.1	3	15	4.4	µG/L		
Magnesium (Mg)		24	24	57100	257000	112071	NA	NA	NA	NA	µG/L		
Manganese (Mn)		22	24	43.5	3290	919	5	8.9	73	5430	µG/L	21	
Nickel (Ni)		12	24	1.1	24	10.6	1	23.9	73	13.3	µG/L		5
Potassium (K)		24	24	23300	105000	49633	NA	NA	NA	NA	µG/L		
Selenium (Se)		4	24	3.4	8.5	5	0.7	5	18	ND	µG/L		
Sodium (Na)		24	24	1980	1390000	471174	NA	NA	NA	NA	µG/L		
Thallium (Tl)	*	2	24	2.7	5.2	4	1.8	5	0.26	2	µG/L	2	2
Tin (Sn)		4	24	104	221	177	2.6	1000	2200	ND	µG/L		
Vanadium (V)		6	24	1	6.2	2.8	0.4	5	26	14	µG/L		
Zinc (Zn)		10	24	4.5	41.4	20.7	4	23.4	1100	24.4	µG/L		4
Volatile Organics													
Acetone		1	12	8	8	8	10	15	370	NA	µG/L		
Methylene chloride	*	2	16	2	15	8.5	3	10	4.1	NA	µG/L	1	
Semivolatile Organics													
Isophorone		1	8	1	1	1	6	10	70	NA	µG/L		

Notes:
* - Indicates chemical was identified as a COPC
N - Indicates chemical is an essential nutrient
SQL - Sample quantitation limit
RBC - Risk-based concentration
µG/L - micrograms per liter
NA - Not applicable or not available

10.8.8.3 Exposure Assessment

Exposure Setting

AOC 687 consists of Building X-55, an earth covered ammunition storage bunker constructed in 1942. The concrete walls and ceiling of the bunker are 4 feet thick. The entire structure is covered by 2 feet of soil. Surrounding the bunker, is a cement and soil containment berm designed to control the bunker door in the event of an explosion. The storage bunker is approximately 29 feet wide, 52 feet long, and 12 feet high. The area is surrounded by a chain-link fence. The AOC is located between Juneau Avenue and the Dredged Materials Area (DMA). The Cooper River and associated wetlands are to the east of the site across Juneau Avenue. The future use of this combined AOC is not certain; however, it is in an area slated to become open buffer space in current base reuse plans.

Since municipal water is readily available basewide, it is highly unlikely that the aquifer will be used as a source of potable or process water. Groundwater exposure pathways would not be completed if the municipal water supply is kept in place. As a highly conservative estimate of potential risk/hazard due to groundwater pathways, residential and industrial scenarios were considered for the combined sites.

Potentially Exposed Populations

Potentially exposed populations are current and future site workers, hypothetical future site residents, and adolescent trespassers. Future site resident and worker exposure scenarios were addressed quantitatively in this risk assessment. Current exposure to workers is discussed quantitatively in relation to the future workers and future residents. The hypothetical future site worker scenario assumed continuous exposure to each impacted medium. Current site workers' exposure would be less than that assumed for the hypothetical future site worker because of limited soil and sediment contact. Therefore, future worker assessment is considered to conservatively represent current site workers. The resident child scenario was considered to conservatively represent the adolescent trespasser. The future site resident scenario was built on the premise that existing features would be removed and replaced with dwellings.

Exposure Pathways

Exposure pathways for both receptor groups are dermal contact and incidental ingestion of surface soil and sediment. Ingestion and inhalation pathways were assessed for the shallow groundwater. The exposure pathways for future residents are the same as those for the future site worker. In addition, the hypothetical future site worker scenario assumed continuous exposure to sediment conditions. To conservatively account for potential exposure, standard soil exposure assumptions were applied to quantify sediment daily intake. This approach was based on the fact that sediment in the ditch along Juneau Avenue is seldom under water. Thus, the potential for contact is similar to that for surface soil. Uniform exposure was assumed for all sample locations. Table 10.8.17 presents the justification for exposure pathways assessed in this HHRA.

Exposure Point Concentrations

As discussed in Section 7 of this RFI, UCLs are generally calculated for data sets consisting of at least 10 samples. Fewer than 10 surface soil and sediment samples were collected; thus, the maximum concentration of each COPC was used to quantify exposure. A hot-spot approach was used to account for the limited extent of identified impacts.

Table 10.8.18 summarizes the groundwater EPC determination. Four shallow monitoring wells were originally installed at this site and sampled once a round for six-rounds. Current EPA guidance favors the arithmetic mean in the most concentrated area of the plume as the EPC for groundwater COPCs. Groundwater COPCs cannot be associated with a single distinct plume. Instead each COPCs was assigned its own "plume". In each case, a separate plume is defined by the monitoring well which produced the highest concentration for a given COPC. The EPC is calculated as the arithmetic mean of the six-rounds of data from the same well. For example, the

Table 10.8.17
AOC 678 and SWMU 16
Exposure Pathways Summary

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Current Land Uses			
Current Users (Site Workers)	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	This exposure pathway was considered insignificant compared to the other pathways.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Shallow groundwater is not currently used as a source of potable or non-residential water at the combined sites.
	Shallow groundwater, Inhalation of volatilized shallow groundwater contaminants	No	Shallow groundwater is not currently used as a source of potable or non-residential water at the combined sites.
	Soil, Incidental ingestion	No (Qualified)	Future site use is considered conservatively representative of current site use.
	Soil, Dermal contact	No (Qualified)	Future site use is considered conservatively representative of current site use.
Future Land Uses			
Future Site Residents (Child and Adult), Future Site Worker	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	This exposure pathway was considered insignificant compared to the other pathways.
	Shallow groundwater, ingestion of contaminants during potable or general use	Yes	Shallow groundwater is not likely to be used as a source of potable or non-residential water at the combined sites. This pathway was addressed as a conservative measure.
	Shallow groundwater, Inhalation of volatilized contaminants during domestic use	Yes	Shallow groundwater is not likely to be used as a source of potable or non-residential water at the combined sites. This pathway was addressed as a conservative measure.
	Soil, Incidental ingestion	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.
	Soil, Dermal contact	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.
	Wild game or domestic animals, Ingestion of tissue impacted by media contamination	No	Hunting/taking of game and/or raising livestock is prohibited within the Charleston, South Carolina, city limits.
	Fruits and vegetables, Ingestion of plant tissues grown in media	No	The potential for significant exposure via this pathway is low relative to that of other exposure pathways assessed.

Table 10.8.18
Statistical Analysis of COPCs
Shallow Groundwater
SWMU 16 and AOC 687
Charleston Naval Complex
Charleston, South Carolina

		Natural Log Transformed			Mean	UCL	MAX	EPC
COPC	n	mean	SD	H-stat	(mg/L)	(mg/L)	(mg/L)	(mg/L)
Arsenic	24	-5.127	1.411	3.108	0.056	0.040	0.131	0.056
Thallium	24	-6.181	0.452	1.932	0.0027	0.0027	0.0052	0.0027
Methylene Chloride	16	-5.934	0.590	2.153	0.0054	0.0044	0.015	0.0054
Chromium	24	-6.659	1.388	3.073	0.0049	0.0082	0.026	0.0082

Notes:

mean arithmetic mean of the log-transformed data
n number of samples analyzed
SD standard deviation for a sample of data
H-stat "H" statistic from Gilbert 1987; cuboidal interpolation was used to determine the value in accordance with USEPA Supplemental Guidance to RAGS, Calculating the Concentration Term
EPC exposure point concentration
UCL 95 percentile upper confidence level mean
MAX maximum reported concentration
MEAN mean in plume

maximum arsenic detection (0.131 mg/L) was from monitoring well 687002 sampled during the fifth-round. The first-round sample from this monitoring well had arsenic at a concentration of 0.0332 mg/L; the second-round sample from this monitoring well had arsenic at a concentration of 0.0737 mg/L; the third-round sample from this monitoring well had an arsenic concentration of nondetect; the fourth-round sample was 0.0393 mg/L; the sixth-round sample from 687002 had arsenic at a concentration of 0.0583 mg/L. The data from the six-rounds and one-half of the SQLs for the nondetected results of the third-round (0.0025 mg/L) yield an average of 0.056 mg/L, which was used as the EPC for arsenic. This same approach was used for methylene chloride. Since no distinct plumes could be identified, the EPA guidance recommending the "mean in the plume" as EPC does not neatly apply to this site. As a conservative measure, 95% UCLs were also calculated and compared to the mean in the most concentrated area of the plume and the greater of the two was selected as the EPC for groundwater COPCs. Because their UCLs exceeded their means in the most concentrated area of the plume, UCLs were used for thallium and chromium EPCs.

Quantification of Exposure

Surface Soil/Sediment

CDIs for ingestion and dermal contact with soil and sediments are shown in Tables 10.8.19 and 10.8.20, respectively.

Groundwater

Table 10.8.21 presents the CDIs for the shallow groundwater exposure pathways. These CDIs apply to both ingestion and inhalation pathways.

Table 10.8.19
Chronic Daily Intakes
Incidental Ingestion of Surface Soil and Sediment
SWMU 16 and AOC 687
Charleston Naval Complex
Charleston, South Carolina

Chemical	Fraction Ingested from Contaminated Source*	Exposure Point Concentration (mg/kg)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident lwa C-CDI (mg/kg-day)	Future Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Chromium (Cr)	1	40.3	5.52E-05	5.15E-04	6.31E-05	1.97E-05	7.04E-06
Manganese (Mn)	1	482	6.60E-04	6.16E-03	7.55E-04	2.36E-04	8.42E-05
Benzo(a)pyrene Equivalents	1	1.31	1.79E-06	1.67E-05	2.04E-06	6.38E-07	2.28E-07
Chlordane	1	5.25	7.19E-06	6.71E-05	8.22E-06	2.57E-06	9.17E-07

Notes:
LWA Lifetime-weighted average; used to calculate carcinogenic CDI, RAGS Parts A and B.
CDI Chronic daily intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
* Reflects the estimated fraction of the site impacted by the corresponding COPC.

Table 10.8.20
Chronic Daily Intakes
Dermal Contact with Surface Soil and Sediment
SWMU 16 and AOC 687
Charleston Naval Complex
Charleston, South Carolina

Chemical	Exposure Point Concentration (mg/kg)	Fraction Contacted from Contaminated Source *	Dermal Absorption Factor+ (unitless)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident lwa C-CDI (mg/kg-day)	Future Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Chromium (Cr)	40.3	1	0.001	2.26E-06	7.47E-06	1.42E-06	1.62E-06	5.77E-07
Manganese (Mn)	482	1	0.001	2.71E-05	8.94E-05	1.69E-05	1.93E-05	6.91E-06
Benzo(a)pyrene Equivalents	1.31	1	0.01	7.33E-07	2.42E-06	4.59E-07	5.24E-07	1.87E-07
Chlordane	5.25	1	0.01	2.95E-06	9.73E-06	1.85E-06	2.11E-06	7.52E-07

Notes:
CDI Chronic daily intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
\+ The dermal absorption factor was applied to the exposure point concentration to reflect the different trans-dermal migration of inorganic versus organic chemicals
* Reflects the estimated fraction of the site impacted by the corresponding COPC.
mg/kg Milligrams per kilogram
mg/kg-day Milligrams per kilogram per day

Table 10.8.21
Chronic Daily Intakes
Ingestion of COPCs in Shallow Groundwater
SWMU 16 and AOC 687
Charleston Naval Complex
Charleston, South Carolina

Chemical	Exposure Point Concentration (mg/liter)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident lwa C-CDI (mg/kg-day)	Future Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Arsenic	0.056	1.54E-03	3.60E-03	8.49E-04	5.51E-04	1.97E-04
Thallium	0.0027	7.53E-05	1.76E-04	4.14E-05	2.69E-05	9.60E-06
Methylene Chloride	0.0054	1.47E-04	3.44E-04	8.10E-05	5.26E-05	1.88E-05
Chromium	0.0082	2.24E-04	5.22E-04	1.23E-04	8.00E-05	2.86E-05

Notes:
LWA Lifetime-weighted average
CDI Chronic daily intake
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk

10.8.8.4 Toxicity Assessment

Toxicity assessment terms and methods are discussed in Section 7. of this report. Table 10.8.22 presents toxicological information specific to each COPC identified at the combined sites. Brief toxicological profiles for each COPC are provided in the following paragraphs.

Arsenic exposure via the ingestion route causes darkening and hardening of the skin in chronically exposed humans. Inhalation exposure to arsenic causes neurological deficits, anemia, and cardiovascular effects (Klaasen, et al., 1986). USEPA set 0.3 μg/kg-day as the RfD for arsenic based on a NOAEL of 0.8 μg/kg-day in a human exposure study. Arsenic's effects on the nervous and cardiovascular systems are primarily associated with acute exposure to higher levels. Exposure to arsenic-containing materials has been shown to cause cancer in humans. Inhalation of these materials can lead to increased lung cancer risk, and ingestion of these materials is associated with increased skin cancer rates. Arsenic has been classified as a group A carcinogen by USEPA, which established the 1.5 $(mg/kg\text{-}day)^{-1}$ SF. As listed in IRIS, the basis for the classification is sufficient evidence from human data. An increased lung cancer mortality was observed in multiple human populations exposed primarily through inhalation. Also, increased mortality from multiple internal organ cancers (liver, kidney, lung, and bladder) and an increased incidence of skin cancer were observed in populations consuming drinking water high in inorganic arsenic. Human milk contains about 3 μg/L arsenic. The tap-water RBC for arsenic is 0.045 μg/L. As listed in IRIS, the critical effect of this chemical is hyperpigmentation, keratosis, and possible vascular complications. The uncertainty factor was determined to be 3 and the modifying factor was determined to be 1.

Table 10.8.22
Toxicological Reference Information
for Chemicals of Potential Concern
SWMU 16 and AOC 687
Charleston Naval Complex
Charleston, South Carolina

	Noncarcinogenic Toxicity Data								*Carcinogenic Toxicity Data*			
Chemical	**Oral Reference Dose (mg/kg-day)**	**Confidence Level**	**Critical Effect**	**Uncertainty Factor Oral**	**Inhalation Reference Dose (mg/kg-day)**	**Confidence Level**	**Critical Effect**	**Uncertainty Factor Inhalation**	**Oral Slope Factor (kg-day/mg)**	**Inhalation Slope Factor (kg-day/mg)**	**Weight of Evidence**	**Tumor Type**
Arsenic	0.0003 a	M	hyperpigmentation	3	NA	NA	NA	NA	1.5 a	15.1 a	A	various
BEQ	NA	NA	NA	NA	NA	NA	NA	NA	7.3 a	3.1 b	B2	mutagen
Chlordane	0.0005 a	L	liver hypertrophy	NA	2E-04	NA	NA	NA	0.35 a	0.35 a	B2	liver carcinoma
Chromium III	1 a	L	NA	100/10	NA	NA	NA	NA	NA	NA a	D	NA
Chromium VI	0.005 a	L	NA	500	1E-07 b	NA	NA	NA	NA	41 a	A	lung
Manganese (food)	0.14 a	M	neurological effects	1	1.43E-05 a	M	neurological effects	1000	NA	NA	D	NA
Methylene chloride	0.06 a	M	liver toxicity	100	0.86 a	NA	liver toxicity	NA	0.0075 a	0.00165 a	B2	liver and lung neoplasms
Thallium	7E-05 c	L	increased SGOT (liver) increased serum LDH	3000	NA	NA	NA	NA	NA	NA	D	NA

Notes:

a = Integrated Risk Information System (IRIS)
b = EPA NCEA - Cincinnati (provisional)
c = RfDo for thallium sulfate corrected for the difference in molecular weight between thallium and thallium sulfate
NA = Not applicable or not available
H = High confidence
L = Low confidence
M = Medium confidence
mg/kg-day = Milligrams per kilogram per day
kg/day/mg = Kilograms per day per milligram

Benzo(a)pyrene equivalents include the following polynuclear aromatic hydrocarbons (PAHs):

Benzo(a)anthracene	TEF 0.1
Benzo(a)pyrene	TEF 1.0
Benzo(b)fluoranthene	TEF 0.1
Benzo(k)fluoranthene	TEF 0.01
Chrysene	TEF 0.001
Dibenz(a,h)anthracene	TEF 1.0
Indeno(1,2,3-cd)pyrene	TEF 0.1

Some PAHs are toxic to the liver, kidney, and blood. However, the toxic effects of the PAHs above have not been well established. There are no RfDs for these PAHs due to a lack of data. All PAHs listed above are classified by USEPA as B2 carcinogens, and their carcinogenicity is addressed relative to that of benzo(a)pyrene, which has an oral SF of 7.3 $(mg/kg\text{-}day)^{-1}$. TEFs, also set by USEPA, are multipliers applied to the detected concentrations, which are subsequently used to calculate excess cancer risk. These multipliers are discussed further in the exposure and toxicity assessment sections. Most carcinogenic PAHs have been classified as such due to animal studies using large doses of purified PAHs. There is some doubt as to the validity of these listings, and the SFs listed in USEPA's RBC table are provisional. However, these PAHs are carcinogens when the exposure involves a mixture of other carcinogenic substances (e.g., coal tar, soot, cigarette smoke). As listed in IRIS, human data specifically linking benzo(a)pyrene to a carcinogenic effect are lacking. There are, however, multiple animal studies in many species demonstrating benzo(a)pyrene to be carcinogenic by numerous routes.

Benzo(a)pyrene has produced positive results in numerous genotoxicity assays. At the June 1992 CRAVE Work Group meeting, a revised risk estimate of benzo(a)pyrene was verified. This section provides information on the aspects of the carcinogenic risk assessment for the agent in question: the USEPA classification and quantitative estimates of exposure. The classification reflects a weight-of-evidence judgment of the likelihood that the agent is a human carcinogen. The quantitative risk estimates are presented in application of a low-dose extrapolation procedure and presented as the risk per mg/kg-day. The unit risk is the quantitative estimate in terms of either risk per μg/L drinking water or risk per $\mu g/m^3$ air breathed. The third form in which risk is presented is drinking water or air concentration providing cancer risks of 1 in 10,000 or 1 in 1,000,000. The carcinogenicity background document provides details on the carcinogenicity values found in IRIS. Users are referred to the Oral Reference Dose and Reference Concentration sections for information on long-term toxic effects other than carcinogenicity.

As listed in IRIS, the basis for the dibenz(a,h)anthracene and benzo(b)fluoranthene B2 classification is no human data and sufficient data from animal bioassays. Benzo(b)fluoranthene produced tumors in mice after lung implantation, intraperitoneal or subcutaneous injection, and skin painting. As listed in IRIS, the basis for the benzo(a)anthracene B2 classification is no human data and sufficient data from animal bioassays. Benzo(a)anthracene produced tumors in mice exposed by gavage; intraperitoneal, subcutaneous or intramuscular injection; and topical application. Benzo(a)anthracene produced mutations in bacteria and in mammalian cells, and transformed mammalian cells in culture. As listed in IRIS, the basis for the benzo(k)fluoranthene B2 classification is no human data and sufficient data from animal bioassays. Benzo(k)fluoranthene produced tumors after lung implantation in mice and when administered with a promoting agent in skin-painting studies. Equivocal results have been found in a lung adenoma assay in mice. Benzo(k)fluoranthene is mutagenic in bacteria. (Klaasen, et al., 1986).

Chlordane is a polycyclic chlorinated pesticide. Acute exposure to high doses of chlordane causes tremors and convulsions. Chronic exposure can cause emotional and neuromuscular disturbances. Exposed individuals revert to normal approximately one week after the source is removed

(Dreisbach, et al., 1987). USEPA has established an oral RfD of 5E-4 mg/kg-day and an oral SF of 0.35 $(mg/kg\text{-}day)^{-1}$.

Chromium exists in two stable, natural forms: CrIII and hexavalent CrVI. Acute exposure to chromium can result in kidney damage following oral exposure or damage to the nasal mucosa and septum following inhalation exposure. Chronic inhalation exposure to CrVI has resulted in kidney and respiratory tract damage, as well as excess lung cancer in both animals and humans following occupational exposure. Only CrVI is thought to be carcinogenic by inhalation (IRIS). Oral RfD values for CrIII and CrVI are 1.0 and 5E-03 (mg/kg-day), respectively. For CrVI, the RfD is based on liver toxicity in rats. For CrVI, the RfD is based on unspecified pathological changes observed in rat studies. In addition, CrVI is considered a group A carcinogen for inhalation exposures, and an inhalation SF of 41 $(mg/kg\text{-}day)^{-1}$ has been established for the hexavalent form. Vitamin supplements contain approximately 0.025 mg of chromium. As listed in IRIS, no critical effects were observed for CrIII. The uncertainty factor was 100 and the modifying factor was 10. As listed in IRIS, no critical effects were observed for CrVI. The uncertainty factor was 500 and the modifying factor was 1.

Manganese is an essential nutrient, but chronic exposure (0.8 mg/kg-day) causes mental disturbances. Studies have shown that manganese uptake from water is greater than manganese uptake from food, and the elderly appear to be more sensitive than children (Klaasen et al., 1986); Dreisbach et al., 1987). USEPA determined the RfD to be 0.14 mg/kg-day based on dietary uptake. USEPA recommended using a modifying factor of 3 when estimating intake from water. In addition, the body roughly absorbs twice as much manganese in water as it does in food. Because of the different uptake rates in water and food, two RfDs were used in this HHRA — one for water and one for food. The RfDs used are 0.047 and 0.023 mg/kg-day, respectively. Inhalation of manganese dust causes neurological effects and increased incidence of pneumonia. An inhalation RfD was set to 1.43E-05 mg/kg-day. According to USEPA, manganese cannot be classified as to its carcinogenicity. Therefore, its cancer class is group D. As listed in IRIS, this classification is based on studies that are inadequate to assess the carcinogenicity of manganese. Manganese is considered essential to human health; the typical vitamin supplement dose is 2.5 mg/day. As listed in IRIS, the critical effects of this chemical in water in the oral summary are CNS effects. The uncertainty factor was 1 and the recommended modifying factor of 3 was used to estimate soil and groundwater intake. This chemical critically affects the CNS. As listed in IRIS, critical effect in the inhalation summary is neuro behavioral impairment. For inhalation uptake, the uncertainty factor was 1,000 and the modifying factor was 1. The IRIS RfC is 5E-05 mg/m^3.

Methylene chloride also known as ***dichloromethane***, is a colorless liquid is widely used as a solvent for various purposes. Available data indicate that the central nervous system is the primary target of inhaled methylene chloride in humans, rats, mice, guinea pigs, and dogs (Fodor, and Winneke 1971; Winneke 1974; Rebert et al., 1989; Savolainen et al., 1981). Other acute human effects following exposure to methylene chloride include irritation of eyes, skin, and respiratory tract, elevated carboxyhemoglobin levels, and circulatory disorders that may be fatal. There are no studies in humans on the effects of acute oral exposure to methylene chloride. No data are available on the adverse health effects in humans after chronic exposure to methylene chloride via any route. Studies in animals suggest that the liver is a target organ following chronic inhalation and oral exposure (Kirschman et al., 1986; Serata et al., 1986b).

In several chronic studies, methylene chloride was administered to experimental animals, either orally or by inhalation. Inhalation studies in animals show a dose-dependent, statistically significant increase in liver and lung adenomas and carcinomas in mice, and benign mammary gland tumors in rats following two year's exposure to methylene chloride (Serata et al., 1986a,b; Burek et al., 1984; Nitschke et al., 1988a; NTP, 1986). However, there is only suggestive evidence of a treatment-associated increase in combined hepatocellular carcinomas and neoplastic nodules provided in drinking water studies (USEPA 1985a,b). An *in vivo* screening test for carcinogenicity induction of lung adenomas in strain A mice gave suggestive positive results for methylene chloride (USEPA, 1980). USEPA's weight-of-evidence classification of methylene chloride is as a probable human carcinogen, Group B2. An oral RfD and inhalation RfD have been issued for methylene chloride as 6.00E-02 (IRIS) and 8.6E-01 (HEAST, 1996), respectively. Oral and inhalation slope factors are 7.50E-03 and 1.65E-03, respectively (IRIS).

Thallium is readily absorbed through the gut and skin. Primary effects are stomach and bowel disturbances, kidney and liver damage, and neurological disturbances. Thallium was used in the past as a rodenticide and ant killer, but its use for these purposes is now prohibited. This element remains in the body for a relatively long time, and could accumulate if the chronic dose is large. USEPA's oral RfD for thallium is 7E-05 mg/kg-day (Klaasen, et al., 1986; Dreisbach, et al., 1987). The uncertainty factor used for thallium is 3,000.

10.8.8.5 Risk Characterization

Surface Soil/Sediment Pathways

Exposure to surface soil and sediment onsite was evaluated under both future residential and industrial (site worker) scenarios applying standard surface soil exposure assumptions. For these scenarios, the incidental ingestion and dermal contact exposure pathways were evaluated. For non-carcinogenic contaminants evaluated for future site residents, hazard was computed separately to address child and adult exposure. Tables 10.8.23 and 10.8.24 present the computed carcinogenic risks and/or HQs associated with the incidental ingestion of and dermal contact with site surface soil and sediments, respectively.

Table 10.8.23
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil and Sediment Ingestion
SWMU 16 and AOC 687
Charleston Naval Complex
Charleston, South Carolina

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used $(mg/kg\text{-}day)^{-1}$	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident LWA ILCR	Future Worker adult Hazard Quotient	Future Worker adult ILCR
Chromium (Cr)	0.005	NA	0.011	0.10	ND	0.0039	ND
Manganese (Mn)	0.14	NA	0.0047	0.044	ND	0.0017	ND
Benzo(a)pyrene Equivalents	NA	7.3	ND	ND	1.5E-05	ND	1.7E-06
Chlordane	0.0005	0.35	0.014	0.13	2.9E-06	0.0051	3.2E-07
SUM Hazard Index/ILCR			0.03	0.3	2E-05	0.01	2E-06

Notes:
NA Not available
ND Not determined due to lack of available information
LWA Lifetime-weighted average; used to calculate excess carcinogenic risk, derived from RAGS Part A.
ILCR Incremental Lifetime excess Cancer Risk
mg/kg-day Milligrams per kilogram per day

Table 10.8.24
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil and Sediment
SWMU 16 and AOC 687
Charleston Naval Complex
Charleston, South Carolina

Chemical	Dermal Adjustment	Oral RfD Used (mg/kg-day)	Oral SF Used $(mg/kg\text{-}day)^{-1}$	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident LWA ILCR	Future Worker adult Hazard Quotient	Future Worker adult ILCR
Chromium (Cr)	0.2	0.001	NA	0.0023	0.0075	ND	0.0016	ND
Manganese (Mn)	0.2	0.028	ND	0.0010	0.0032	ND	0.00069	ND
Benzo(a)pyrene Equivalents	0.5	NA	14.6	ND	ND	6.7E-06	ND	2.7E-06
Chlordane	0.5	0.00025	0.7	0.012	0.039	1.3E-06	0.0084	5.3E-07
SUM Hazard Index/ILCR				0.02	0.05	8E-06	0.01	3E-06

Notes:
NA Not available
ND Not determined due to lack of available information
lwa Lifetime-weighted average; used to calculate excess carcinogenic risk, derived from RAGS Part A.
ILCR Incremental Lifetime excess Cancer Risk
* Dermal to absorbed dose adjustment factor is applied to adjust for oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency, which should not be applied to dermal exposure and dermal CDI).

Hypothetical Site Residents

The ingestion ILCR (based on the adult and child lifetime-weighted average) for combined AOC 687 surface soil and sediment is 2E-05. The dermal pathway ILCR is 8E-6. Benzo(a)pyrene equivalents and chlordane were the primary contributors for each pathway.

The computed hazard indices for the adults resident were less than 0.1 for the soil ingestion and dermal contact pathways. The computed hazard indices for the child ingestion and dermal contact pathways were 0.3 and 0.05, respectively.

Future Site Workers

Site worker ILCRs are 2E-06 and 3E-06 for the ingestion and dermal contact pathways, respectively. Benzo(a)pyrene equivalents and chlordane were the primary contributors for each pathway. The hazard indices for both pathways were below 0.1.

The area which comprises combined AOC 687 is an reinforced earthen munitions bunker and associated driveway. Soil samples were taken around the perimeter of combined AOC 687. Sediment sampling was restricted to the ditch which runs perpendicular to the driveway along the road to the marina. Current site users have little chance of exposure to affected sediment as their principle function is maintenance and operation of the bunker proper. As a result, the risk/hazard projections discussed above are considered gross overestimates should existing site features and functions be maintained under future use scenarios.

Groundwater Pathways

Exposure to shallow groundwater onsite was evaluated under both future residential and industrial scenarios. The ingestion and inhalation exposure pathways were evaluated assuming the site groundwater will be used for potable and/or domestic purposes and that an unfiltered well drawing from the corresponding water-bearing zone, will be installed. For non-carcinogenic contaminants evaluated relative to future site residents, hazard was computed separately for child and adult receptors. Tables 10.8.25 and 10.8.26 presents the risk and hazard for the ingestion and inhalation exposure pathways, respectively.

Hypothetical Site Residents

The shallow groundwater ingestion ILCR for hypothetical site residents is 1E-03, and the inhalation pathway ILCR was 1E-07. For the ingestion pathway, arsenic is the primary contributor to ILCR and methylene chloride is the sole contributor for the inhalation pathway. For the ingestion pathway, the hazard indices for the adult and child resident are 6 and 15, respectively. Arsenic and thallium were the primary contributors to hazard index estimates. Inhalation pathway hazard indices were less than 0.01 for adult and child receptors.

Future Site Workers

The shallow groundwater risk posed to future site workers is 3E-04 and 3E-08 for the ingestion and inhalation pathways, respectively. For the ingestion pathway, arsenic is the primary contributor to ILCR and methylene chloride is the sole contributor for the inhalation pathway. For the ingestion pathway, the hazard index for the adult worker was 2 with arsenic as the primary contributor. The inhalation pathway hazard index was less than 0.01.

Current Site Workers

Shallow groundwater is not currently used as a potable water source for combined AOC 687 or other areas of Zone I. In the absence of a completed exposure pathway, no threat to human health is posed by reported shallow groundwater quality.

COCs Identified

Identification of chemicals of concern was based on cumulative (all pathway) risk and hazard projected for this site. USEPA has established a generally acceptable risk range of 1E-04 to

Table 10.8.25
Hazard Quotients and Incremental Lifetime Cancer Risks
Shallow Groundwater Ingestion
SWMU 16 and AOC 687
Charleston Naval Complex
Charleston, South Carolina

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used $(mg/kg\text{-}day)^{-1}$	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident LWA ILCR	Future Worker adult Hazard Quotient	Future Worker adult ILCR
Arsenic	0.0003	1.5	5.1	12	1.3E-03	1.8	3.0E-04
Thallium	0.00007	NA	1.1	2.5	ND	0.38	ND
Methylene Chloride	0.06	0.0075	0.0025	0.0057	6.1E-07	0.00088	1.4E-07
Chromium	0.005	NA	0.045	0.10	ND	0.016	ND
SUM Hazard Index/ILCR			6	15	1E-03	2	3E-04

Notes:
NA Not available
ND Not determined due to lack of available information
LWA Lifetime-weighted average; used to calculate excess carcinogenic risk, derived from *RAGS Part A.*
ILCR Incremental Lifetime excess Cancer Risk

Table 10.8.26
Hazard Quotients and Incremental Lifetime Excess Cancer Risks
Inhalation of Volatiles in Groundwater
SWMU 16 and AOC 687
Charleston Naval Complex
Charleston, South Carolina

Chemical	Inhalation Rf Used (mg/kg-day)	Inhalation SF Used $(mg/kg\text{-}day)^{-1}$	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident LWA ILCR	Future Worker adult Hazard Quotient	Future Worker adult ILCR
Methylene Chloride	0.86	0.00165	0.00017	0.00040	1.3E-07	0.000061	3.1E-08
SUM Hazard Index/ILCR			0.0002	0.0004	1E-07	0.00006	3E-08

Notes:
LWA Lifetime-weighted average; used to calculate excess carcinogenic risk, derived from *RAGS Part A*
ILCR Incremental lifetime excess cancer risk

1E-06, and a hazard index threshold of 1.0 (unity). In this HHRA, a COC was considered to be any chemical contributing to a cumulative risk level of 1E-06 or greater and/or a cumulative hazard index above 1.0, if its individual ILCR exceeds 1E-06 or its hazard quotient exceeds 0.1. For carcinogens, this approach is relatively conservative because a cumulative risk level of 1E-04 (and individual ILCR of 1E-06) is recommended by USEPA Region IV as the trigger for establishing COCs. The COC selection method was used to more comprehensively evaluate chemicals contributing to carcinogenic risk or noncarcinogenic hazard during the remedial goal option development. Table 10.8.27 presents the COCs identified on a medium-specific basis.

Hypothetical Site Residents (future land use)

Surface Soil/Sediment

Benzo(a)pyrene equivalents and chlordane were identified as COCs for this scenario based on their contribution to sum ILCR.

Future Site Workers (current land use)

Benzo(a)pyrene equivalents were identified as COCs for this scenario based on their contribution to ILCR projections.

Benzo(a)pyrene equivalents were detected in only one of two sediment samples and no surface soil samples collected at combined AOC 687. The impacted location (687M0002) is in a drainage ditch immediately adjacent to Juneau Avenue. Based on results for soil samples collected close proximity to the paint and munitions storage area, it does not appear that a source related to current or past operations exists. The benzo(a)pyrene equivalents detected in the impacted sediment sample may have originated with road asphalt and/or roadbase material.

Table 10.8.27
Summary of Risk and Hazard-based COCs
SWMU 16 and AOC 687
Charleston Naval Complex
Charleston, South Carolina

Medium	Exposure Pathway		Future Resident Adult Hazard Quotient	Future Resident Child Hazard Quotient	Future Resident LWA ILCR	Site Worker Hazard Quotient	Site Worker ILCR	Identification of COCs
Surface Soil/Sediment	Incidental Ingestion	Chromium (Cr)	0.011	0.10	ND	0.0039	ND	
		Manganese (Mn)	0.0047	0.044	ND	0.0017	ND	
		Benzo(a)pyrene Equivalent	ND	ND	1.5E-05	ND	1.7E-06	2 4
		Chlordane	0.014	0.13	2.9E-06	0.0051	3.2E-07	2
	Dermal Contact	Chromium (Cr)	0.0023	0.0075	ND	0.0016	ND	
		Manganese (Mn)	0.0010	0.0032	ND	0.00069	ND	
		Benzo(a)pyrene Equivalent	ND	ND	6.7E-06	ND	2.7E-06	2 4
		Chlordane	0.012	0.039	1.3E-06	0.0084	5.3E-07	2
Surface Soil/Sediment Pathway Sum			0.05	0.33	3E-05	0.02	5E-06	
Shallow Groundwater	Ingestion	Arsenic	5.1	12	1.3E-03	1.8	3.0E-04	1 2 3 4
		Thallium	1.1	2.5	ND	0.38	ND	1 3
		Methylene Chloride	0.0025	0.0057	6.1E-07	0.00088	1.4E-07	
		Chromium	0.045	0.10	ND	0.016	ND	1
	Inhalation	Methylene Chloride	0.00017	0.00040	1.3E-07	0.000061	3.1E-08	
Shallow Groundwater Pathway Sum			6	15	1E-03	2	3E-04	
Sum of All Pathways			6	15	1E-03	2	3E-04	

Notes:
ND = not determined due to the lack of available risk information.
ILCR = incremental excess lifetime cancer risk
HI = hazard index
LWA = Lifetime-weighted average
1- Chemical is a COC by virtue of projected child residence non-carcinogenic hazard.
2- Chemical is a COC by virtue of projected future resident lifetime ILCR.
3- Chemical is a COC by virtue of projected site worker non-carcinogenic hazard.
4- Chemical is a COC by virtue of projected site worker ILCR.

Hypothetical Site Residents (future land use)

Groundwater

The carcinogenic COC identified in shallow groundwater is arsenic based on its contribution to cumulative residential ILCR projections. Arsenic, chromium, and thallium were identified as groundwater pathway COCs based on their contribution to cumulative residential HI projections.

Future Site Workers (current land use)

The carcinogenic COC identified in shallow groundwater is arsenic based on its contribution to cumulative ILCR. Arsenic and thallium were identified as groundwater pathway COCs based on their contribution to cumulative industrial HI projections.

The extent of the COCs identified in shallow groundwater are briefly discussed below. Arsenic was detected at a concentration exceeding its tap-water RBC (0.045 μg/L) in 13 shallow groundwater samples. Six samples exceeded the background value (23 μg/L) for arsenic. Three samples exceeded the MCL of 50 μg/L. Thallium was detected at concentrations exceeding its tap-water RBC (0.26 μg/L) in two fourth-round groundwater samples (687001 and 687002). Thallium also exceeded its MCL (2 μg/L) in these fourth-round groundwater samples. Chromium was detected at concentrations exceeding its tap-water RBC (18 μg/L) and background value (14.3 μg/L) in three sixth-round groundwater samples (687001, 687003, and 687004).

10.8.8.6 Risk Uncertainty

Characterization of Exposure Setting and Identification of Exposure Pathways

The potential for high bias is introduced through the exposure setting and pathway selection due to the highly conservative assumptions (i.e., future residential use) recommended by USEPA Region IV when assessing potential future and current exposure. The exposure assumptions made in the site worker scenario are highly conservative and would tend to overestimate exposure. Current site workers are infrequently exposed to sediment onsite. The area impacted by COPCs is by a roadside ditch which runs perpendicular to the driveway leading to the munitions bunker along Juneau Avenue. As a result, minimal surface soil and sediment exposure would be expected.

Residential use of the site would not be expected, based on current site uses features. Current reuse plans call for continued commercial/industrial use of Zone I, specifically as open buffer space. If this area were to be used as a residential site, the munitions bunker would have to be removed along with asphalt surfaces, and surface soil and sediment conditions would likely change — the soils could be covered with landscaping soil, and/or houses. Consequently, exposure to current surface soil and sediment conditions would not be likely under a true future residential scenario. These factors indicate that exposure pathways assessed in this HHRA would generally overestimate the risk and hazard posed to current site workers and future site residents.

Shallow groundwater is not currently used at the combined sites for potable or industrial purposes. A basewide system provides drinking and process water to buildings throughout Zone I. This system is slated to remain in operation under the current base reuse plan. As a result, shallow groundwater would not be expected to be used under future site use scenarios. Therefore, the screening scenario established to project risk/hazard associated with shallow groundwater exposure is highly conservative, and associated pathways are not expected to be completed in the future.

Determination of Exposure Point Concentrations

The maximum concentrations of each surface soil COPC were applied as EPCs. Use of maximum detected concentrations as EPCs represents a conservative assumption and likely results in an overestimation of risk and hazard.

The 95% UCLs or arithmetic means of the detected concentrations were applied as the EPCs for groundwater. Region IV guidance states that the average concentration of each COPC in the most concentrated area of the plume should be used as the EPC. Since a plume cannot be readily defined, this guidance applies only marginally. Groundwater data variability contributes greatly to uncertainty through spatial variability. Ninety-five percent UCLs were calculated to provide point estimates for groundwater to account for this uncertainty, thus providing an upper-bound estimate for modeling exposure. For any given COPC, the placement of monitoring wells in uncontaminated areas of the aquifer could cause a low bias on the 95% UCL. As a result, the arithmetic mean of detected concentrations was compared to the 95% UCL and the larger value was selected as the EPC. To address uncertainty resulting from the selection of EPCs, risk/hazard maps were included in the risk summary section. The maps also provide additional perspective.

Frequency of Detection and Spatial Distribution

Surface Soil/Sediment

Benzo(a)pyrene equivalents, chromium, and chlordane were detected at elevated levels in only one sediment sample (687M000201). This sample was collected in a stagnant area where sediment transported by surface water would tend to deposit. Manganese was detected in both sediment samples. Manganese exceeded the RBC, but not the background in one location (687M0002). Chromium and manganese were also detected in all four surface soil samples taken. The maximum chromium surface soil concentration (40 mg/kg) was detected at 687SB004 and exceeded its RBC and background concentration. Manganese exceeded its RBC in three of the four surface soil samples taken (687SB001, 687SB002, and 687SB004). The maximum manganese surface soil concentration (482 mg/kg) was detected at 687SB004 and exceeded its RBC and background concentration.

Groundwater

Methylene chloride was detected in two of 12 shallow groundwater samples analyzed. One first-round sample (687002) exceeded the RBC. Arsenic is a naturally occurring inorganic constituent detected in 13 of 24 shallow groundwater samples. Thirteen results exceeded the RBC and six results exceeded the background concentration of 23 μg/L. Thallium exceeded its RBC and MCL in two fourth-round shallow groundwater samples. Chromium exceeded its RBC and background concentration in three sixth-round shallow groundwater samples.

Quantification of Risk/Hazard

As indicated by the discussions above, the uncertainty inherent in the risk assessment process is great. In addition, many site-specific factors have affected the uncertainty of this assessment that would upwardly bias the risk and hazard estimates. Exposure pathway-specific sources of uncertainty are discussed below.

Surface Soil/Sediment

Of the CPSSs screened from formal assessment, none was reported at concentrations within approximately 10% of its RBC. This minimizes the likelihood of potentially significant cumulative risk/hazard with respect to the eliminated CPSSs. Aluminum, and arsenic exceeded their RBCs, but these elements did not exceed the soil background concentrations used for comparison. Therefore, they were eliminated from formal assessment based on comparisons to corresponding background concentrations.

Central tendency (CT) analysis was not formally performed for the combined sites' sediment (as surface soil), but a simplified approach was taken to assess the potential influences of CT assumptions. The central tendency assumption for residential exposure duration is nine years compared to the 30 year assumption for RME. The CT exposure frequency assumption is 234 days/year compared to 350 days/year RME. If all other exposure assumptions remain fixed, application of the CT exposure duration and frequency would result in risk projections 80% below the RME. At CT, the residential soil/sediment pathway-related risk (incidental ingestion and dermal contact) would drop from 3E-05 to 8E-06.

Although the combined sites' future land use is unknown, both the worker and residential exposure scenarios were assessed in this HHRA. Current base reuse plans call for conversion of the area to an open buffer space around a marine cargo terminal. As previously discussed, it is likely that these scenarios would lead to overestimates of risk and/or hazard.

Groundwater

Of the CPSSs screened from formal assessment, no CPSS was eliminated from formal assessment which was reported at concentrations approaching its RBC. Manganese exceeded its tap-water RBC, but not its background concentration. Therefore, it was eliminated from formal assessment based on comparison to background concentration. Results of the Wilcoxon rank sum test did not result in the inclusion of any inorganic element which would have otherwise been screened out of the assessment through comparison to the background concentration.

Groundwater is not currently used as a potable water source at the combined sites, or on the CNC or in the surrounding area. Municipal water is readily available. As previously mentioned, it is highly unlikely that the site will be developed as a residential area, and it is unlikely that a potable use well would be installed onsite. If residences were constructed onsite and an unfiltered well were to be installed, it is probable that salinity and dissolved solids would preclude this aquifer from being an acceptable potable water source.

Background Risk

Surface Soil/Sediment

Aluminum, and arsenic were detected in the combined sites surface soil or sediment at concentrations exceeding their RBCs. These elements were eliminated from consideration in the risk assessment based on comparison to corresponding background values. It is not unusual for naturally occurring or background concentrations of some elements to exceed risk-based concentrations. It is the risk assessment's function to identify excess risk and/or hazard, or that which exceeds background levels. The following discusses the residential scenario risk/hazard associated with background concentrations of aluminum, and arsenic.

Aluminum: The maximum surface soil concentration of aluminum (19,300 mg/kg) for the combined sites equates with hazard quotients of 0.3 and 0.01 for the residential child and site worker, respectively. The background value for aluminum (27,400 mg/kg) results in hazard quotients of 0.04 and 0.02 for the residential child and site worker, respectively.

Arsenic: The maximum surface soil concentration of arsenic (12.4 mg/kg) equates with ILCRs of 3E-05 and 5E-06 for the residential and site worker scenarios, respectively. The maximum reported concentration of arsenic equates with hazard quotients of 0.6 and 0.03 for the residential child and site worker, respectively. The background value for arsenic (21.6 mg/kg) equates with ILCRs of 6E-06 and 8E-06, and hazard quotients of 0.1 and 0.05 for the residential and site worker scenarios, respectively.

Groundwater

Manganese was detected in groundwater samples at a concentration exceeding its RBC. This inorganic was eliminated from consideration in the risk assessment based on comparison to its background value. The following discusses the residential scenario risk/hazard associated with background concentrations of manganese.

The maximum reported concentration of manganese (3,290 μg/L) yielded hazard quotients of 4 and 3 for the residential and site worker scenarios, respectively. Hazard quotients resulting from the background value for manganese (5,430 μg/L) were 7 and 5 for the residential child and the site worker, respectively.

10.8.8.7 Risk Summary

The risk and hazard posed by contaminants at the combined sites were assessed for the future site worker and the hypothetical future site resident under reasonable maximum exposure assumptions. For surface soil and sediment, the incidental ingestion and dermal contact pathways were assessed in this HHRA. For groundwater, ingestion and inhalation exposure pathways were assessed. Table 10.8.28 summarizes risk for each pathway/receptor group evaluated for the combined sites.

Soil/Sediment — Residential Scenario

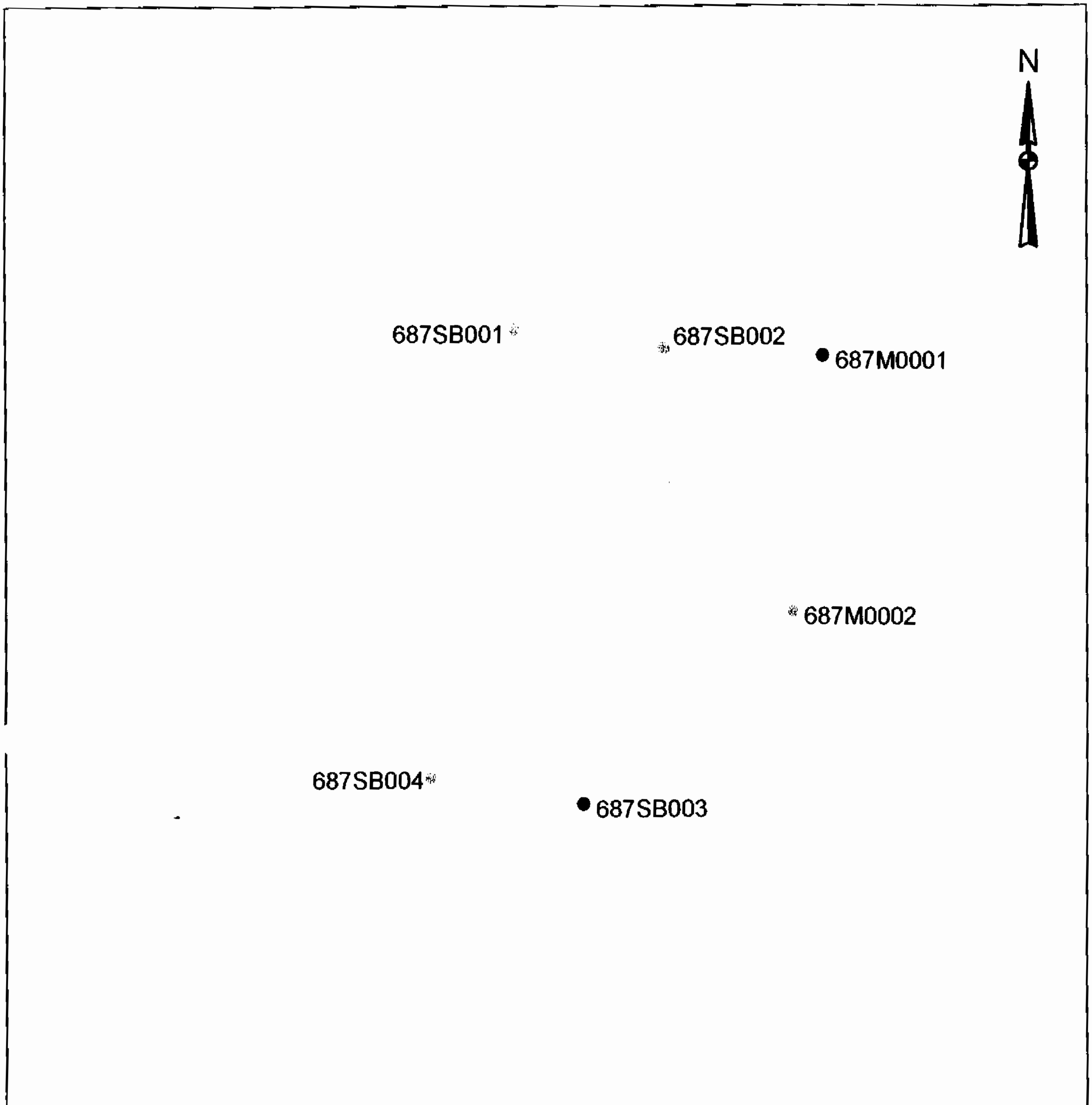
The residential soil and sediment pathway COCs identified for the combined sites are benzo(a)pyrene equivalents, chlordane, and chromium. Figures 10.8.10 and 10.8.11 illustrate point risk and hazard estimates for the combined sites based on surface soil and sediment exposure pathways under a future residential scenario. Table 10.8.29 summarizes the risk and hazard contribution of each COPC at each sample location. This point risk map is based on the unlikely assumption that a potential future site resident will be chronically exposed to specific points. Exposure to surface soil conditions is more likely the result of uniform exposure to the soil conditions of the entire site (or exposure unit area) rather than specific points. With this in mind, risk maps supplemented by the tables are useful because they allow the reader to visualize how chemicals driving risk estimates are spatially distributed across the site.

Only one sample location yielded ILCRs that were greater than 1E-06 (687M0002). Benzo(a)pyrene equivalents and chlordane were the primary contributors to risk estimate of 3E-05 at 687M0002. Hazard estimates ranged from 0.04 at (687SB003) to 0.3 at (687M0002), with a mean hazard index of 0.2.

Table 10.8.28
Summary of Risk and Hazard
SWMU 16 and AOC 687
Charleston Naval Complex
Charleston, South Carolina

Medium	Exposure Pathway	HI (Adult)	HI (Child)	ILCR (LWA)	HI (Worker)	ILCR (Worker)
Surface Soil/Sediment	Incidental Ingestion	0.030	0.28	2E-05	0.011	2E-06
	Dermal Contact	0.015	0.050	8E-06	0.011	3E-06
Shallow Groundwater	Ingestion	6	15	1E-03	2	3E-04
	Inhalation	0.0002	0.0004	1E-07	0.00006	3E-08
Sum of All Pathways		6	15	1E-03	2	3E-04

Notes:
ND = not determined due to the lack of available risk information.
ILCR = incremental excess lifetime cancer risk.
HI = hazard index
LWA = Lifetime-weighted average



LEGEND

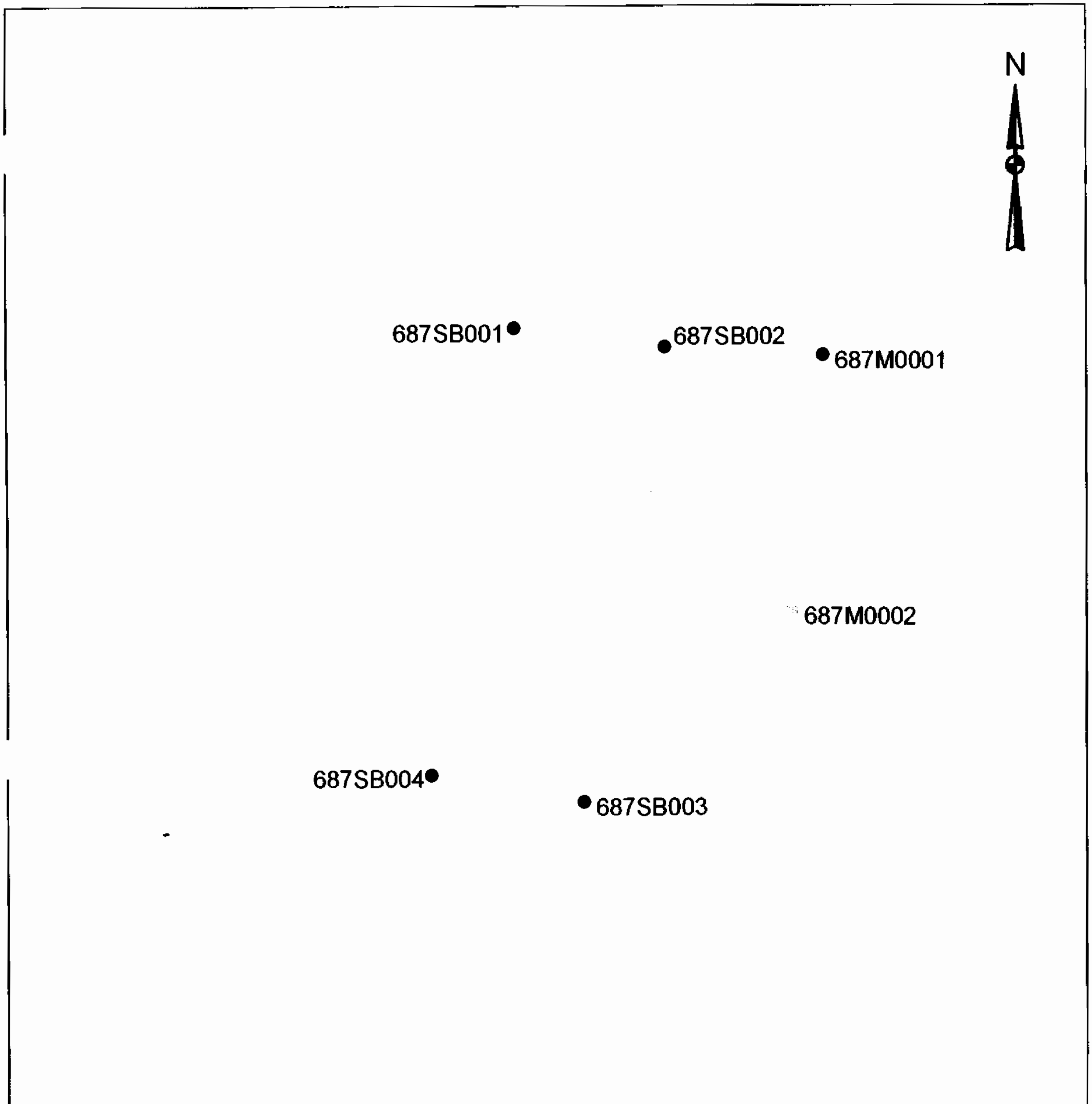
- NO COPCs
- 0 to 0.1
- 0.1 to 0.5
- 0.5 to 1.0
- 1.0 to 3.0
- > 3.0

40 0 40 80 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.8.11
ZONE I
AOC 687

SURFACE SOIL HAZARD INDEX
RESIDENTIAL SCENARIO



LEGEND

- NO COPCs
- < 1E-6
- 1E-6 to 5E-6
- 5E-6 to 1E-5
- 1E-5 to 1E-4
- > 1E-4

40 0 40 80 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.8.10
ZONE I
AOC 687

SURFACE SOIL POINT RISK
RESIDENTIAL SCENARIO

Table 10.8.29
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
AOC 687 and SWMU 16
Charleston Naval Complex
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	Risk (E-06)
Sediment						
687	0001	Chromium (Cr)	22.8	mg/kg	0.063	NA
687	0001	Manganese (Mn)	103	mg/kg	0.030	NA
		Total			0.093	NA
687	0002	Benzo(a)pyrene equivalents	1304.65	ug/kg	NA	21.605
687	0002	Chlordane	5250	ug/kg	0.173	4.168
687	0002	Chromium (Cr)	40.25	mg/kg	0.110	NA
687	0002	Manganese (Mn)	203	mg/kg	0.059	NA
		Total			0.343	25.77
Surface Soil						
687	B001	Chromium (Cr)	25.2	mg/kg	0.069	NA
687	B001	Manganese (Mn)	205	mg/kg	0.060	NA
		Total			0.129	NA
687	B002	Chromium (Cr)	33.5	mg/kg	0.092	NA
687	B002	Manganese (Mn)	316	mg/kg	0.092	NA
		Total			0.184	NA
687	B003	Chromium (Cr)	10.55	mg/kg	0.029	NA
687	B003	Manganese (Mn)	49.75	mg/kg	0.015	NA
		Total			0.043	NA
687	B004	Chromium (Cr)	40	mg/kg	0.110	NA
687	B004	Manganese (Mn)	482	mg/kg	0.141	NA
		Total			0.250	NA

Soil — Site Worker Scenario

The industrial soil and sediment pathway COCs identified for the combined sites are benzo(a)pyrene equivalents. Figure 10.8.12 illustrates point risk estimates for the combined sites based on soil and sediment exposure pathways under a future site worker/industrial scenario. Table 10.8.30 summarizes the risk and hazard contribution of each COPC at each sample location.

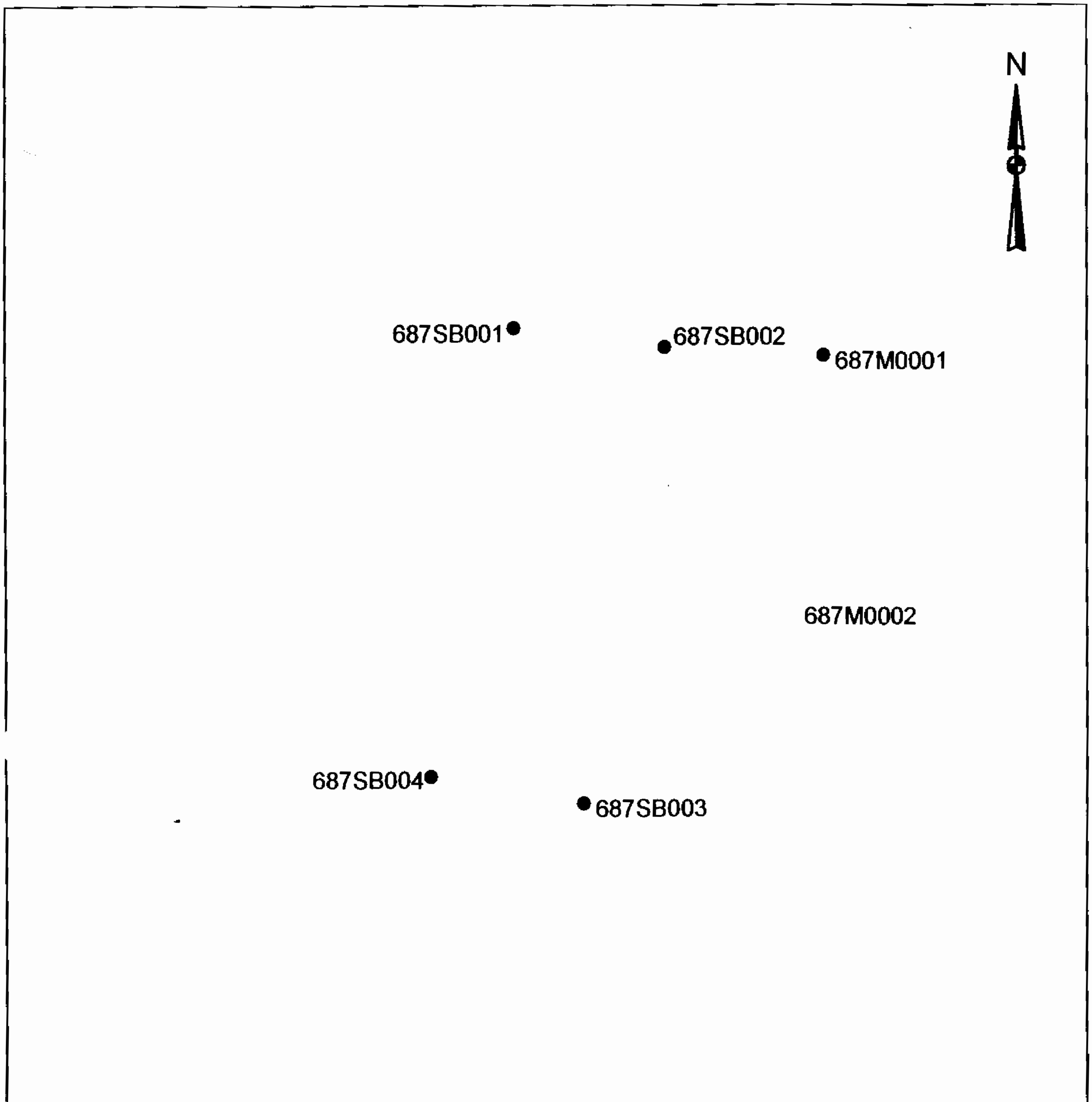
Only one sample location yielded an ILCR greater than 1E-06 (687M0002). Benzo(a)pyrene equivalents were the primary contributor to risk at 687M0002, while chlordane was a secondary contributor. Risk estimates were 5E-06 at 687M0002.

Groundwater — Residential Scenario

Arsenic, chromium, and thallium were identified as groundwater pathway COCs. As shown in Table 10.8.31 and Figure 10.8.13, arsenic was the primary contributor to risk projections for the combined sites' groundwater. Methylene chloride was the secondary contributor. Risk estimates ranged from 3E-07 (68700301) to 3E-03 (68700205), with a mean ILCR of 4E-04. Arsenic was the primary contributor to hazard estimates, while methylene chloride was a secondary contributor. Figure 10.8.14 illustrates point hazard estimates for groundwater for the residential scenario. Hazard estimates ranged from 0.002 (68700301) to 28 (68700205), with a mean hazard index of 4.

Groundwater — Industrial Scenario

Arsenic, chromium, and thallium were identified as groundwater pathway COCs. As shown in Table 10.8.32 and Figure 10.8.15, arsenic was the primary contributor to risk projections for the combined sites' groundwater. Methylene chloride was the secondary contributor. Risk estimates ranged from 1E-07 (68700301) to 1E-03 (68700205), with a mean ILCR of 2E-04.



LEGEND

- NO COPCs
- < 1E-6
- 1E-6 to 5E-6
- 5E-6 to 1E-5
- 1E-5 to 1E-4
- > 1E-4

40 0 40 80 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.8.12
ZONE I
AOC 687

SURFACE SOIL POINT RISK
INDUSTRIAL SCENARIO

Table 10.8.30
Point Estimates of Risk and Hazard - Surface Soil Pathways
Site Worker Scenario
AOC 687 and SWMU 16
Charleston Naval Complex
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	Risk (E-06)
Sediment						
687	0001	Chromium (Cr)	22.8	mg/kg	0.0031	NA
687	0001	Manganese (Mn)	103	mg/kg	0.0015	NA
		Total			0.0047	NA
687	0002	Benzo(a)pyrene equivalents	1304.65	ug/kg	NA	4.39
687	0002	Chlordane	5250	ug/kg	0.0136	0.85
687	0002	Chromium (Cr)	40.25	mg/kg	0.0056	NA
687	0002	Manganese (Mn)	203	mg/kg	0.0030	NA
		Total			0.0221	5.24
Surface Soil						
687	B001	Chromium (Cr)	25.2	mg/kg	0.0035	NA
687	B001	Manganese (Mn)	205	mg/kg	0.0030	NA
		Total			0.0065	NA
687	B002	Chromium (Cr)	33.5	mg/kg	0.0046	NA
687	B002	Manganese (Mn)	316	mg/kg	0.0046	NA
		Total			0.0093	NA
687	B003	Chromium (Cr)	10.55	mg/kg	0.0015	NA
687	B003	Manganese (Mn)	49.75	mg/kg	0.0007	NA
		Total			0.0022	NA
687	B004	Chromium (Cr)	40	mg/kg	0.0055	NA
687	B004	Manganese (Mn)	482	mg/kg	0.0071	NA
		Total			0.0126	NA

Table 10.8.31
Point Estimates of Risk and Hazard - Groundwater Pathways
Residential Scenario
AOC 687 and SWMU 16
Charleston Naval Complex
Charleston, South Carolina

AOC	Location	Round	Parameter	Concentration	Units	Hazard Index	Risk (E-06)
687	W001	01	Arsenic (As)	38.6	ug/L	8.23	861.14
687	W001	02	No COPCs			NA	NA
687	W001	03	No COPCs			NA	NA
687	W001	04	Thallium (Tl)	5.2	ug/L	4.16	NA
687	W001	05	No COPCs			NA	NA
687	W001	06	Arsenic (As)	3.3	ug/L	0.70	73.62
687	W001	06	Chromium (Cr)	20.9	ug/L	0.06	NA
			Total			0.76	73.62
687	W002	01	Arsenic (As)	33.2	ug/L	7.07	740.67
687	W002	01	Methylene chloride	15	ug/L	0.02	2.04
687	W002	01	Chromium (Cr)	2.1	ug/L	0.01	NA
			Total			7.10	742.70
687	W002	02	Arsenic (As)	73.7	ug/L	15.70	1644.19
687	W002	03	No COPCs			NA	NA
687	W002	04	Arsenic (As)	39.3	ug/L	8.37	876.75
687	W002	04	Thallium (Tl)	2.7	ug/L	2.16	NA
			Total			10.53	876.75
687	W002	05	Arsenic (As)	131	ug/L	27.91	2922.50
687	W002	06	Arsenic (As)	58.3	ug/L	12.42	1300.63
687	W002	06	Chromium (Cr)	12.7	ug/L	0.03	NA
			Total			12.46	1300.63
687	W003	01	Methylene chloride	2	ug/L	0.002	0.27
687	W003	01	Chromium (Cr)	4.6	ug/L	0.013	NA
			Total			0.015	0.27
687	W003	02	No COPCs			NA	NA
687	W003	03	Arsenic (As)	5.6	ug/L	1.19	124.93
687	W003	03	Chromium (Cr)	1.7	ug/L	0.005	NA
			Total			1.20	124.93

Table 10.8.31
Point Estimates of Risk and Hazard - Groundwater Pathways
Residential Scenario
AOC 687 and SWMU 16
Charleston Naval Complex
Charleston, South Carolina

AOC	Location	Round	Parameter	Concentration	Units	Hazard Index	Risk (E-06)
687	W003	04	No COPCs			NA	NA
687	W003	05	Arsenic (As)	4.1	ug/L	0.87	91.47
687	W003	06	Arsenic (As)	4.3	ug/L	0.92	95.93
687	W003	06	Chromium (Cr)	20.7	ug/L	0.06	NA
			Total			0.97	95.93
687	W004	01	Arsenic (As)	6.3	ug/L	1.34	140.55
687	W004	01	Chromium (Cr)	1.5	ug/L	0.004	NA
			Total			1.35	140.55
687	W004	02	No COPCs			NA	NA
687	W004	03	No COPCs			NA	NA
687	W004	04	No COPCs			NA	NA
687	W004	05	Arsenic (As)	8.2	ug/L	1.75	182.94
687	W004	06	Arsenic (As)	3.3	ug/L	0.70	73.62
687	W004	06	Chromium (Cr)	26.1	ug/L	0.07	NA
						0.77	73.62

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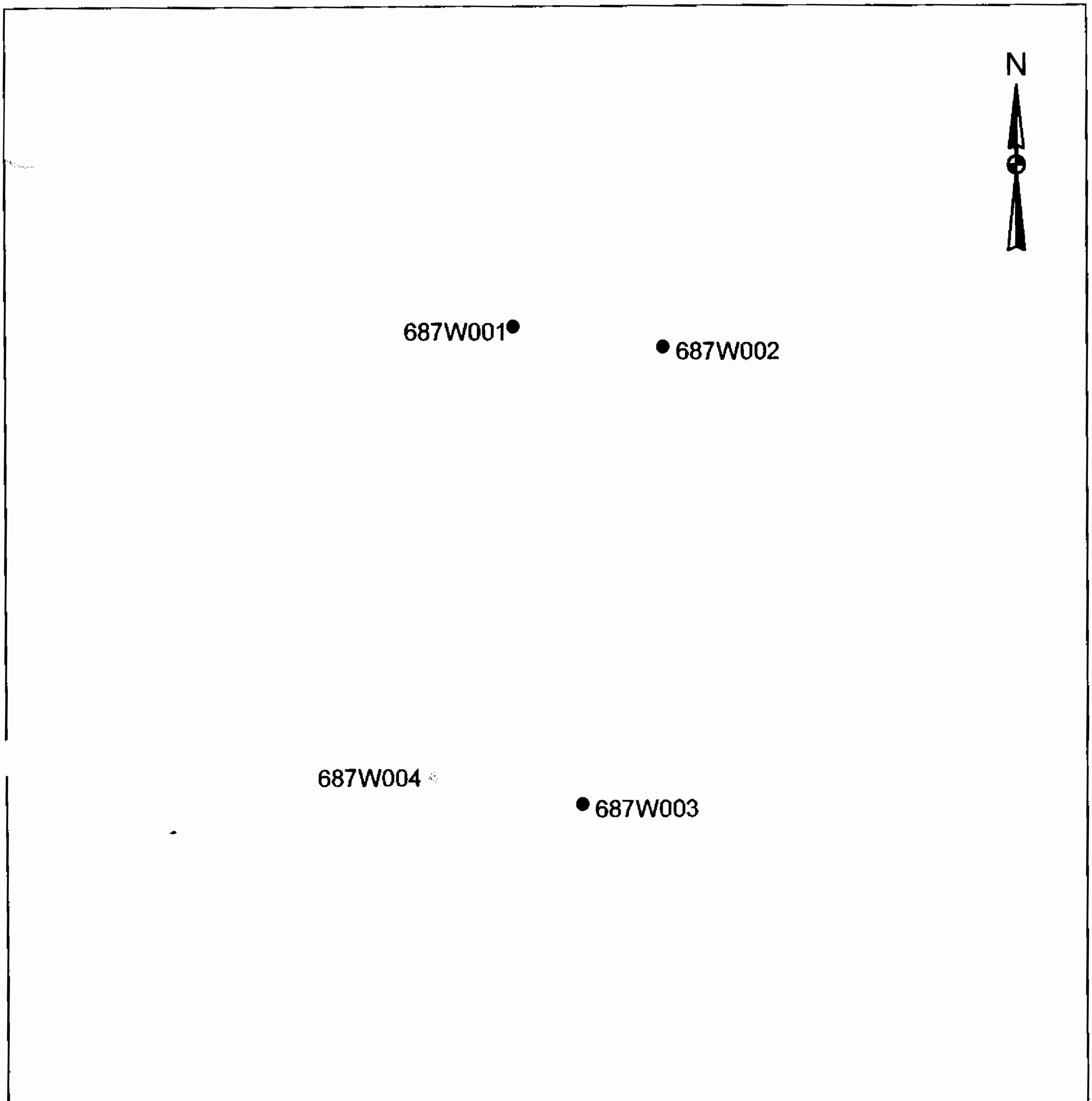


LEGEND

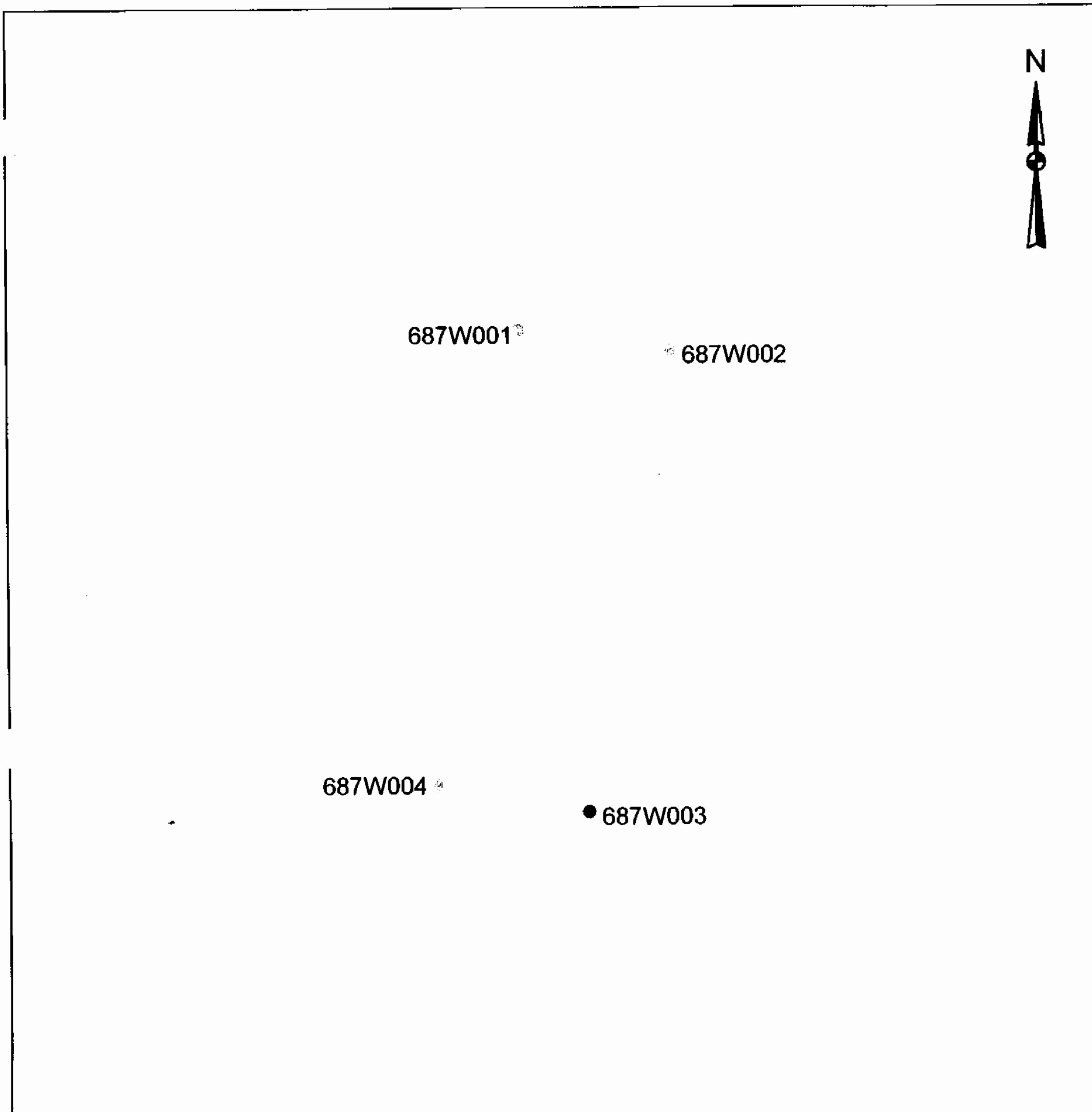
- NO COPCs
- < 1E-6
- 1E-6 to 5E-6
- 5E-6 to 1E-5
- 1E-5 to 1E-4
- > 1E-4

40 0 40 80 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.8.13
ZONE I
AOC 687

GROUNDWATER POINT RISK
RESIDENTIAL SCENARIO



LEGEND

- NO COPCs
- 0 to 0.1
- 0.1 to 0.5
- 0.5 to 1.0
- 1.0 to 3.0
- > 3.0

40 0 40 80 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.8.14
ZONE I
AOC 687

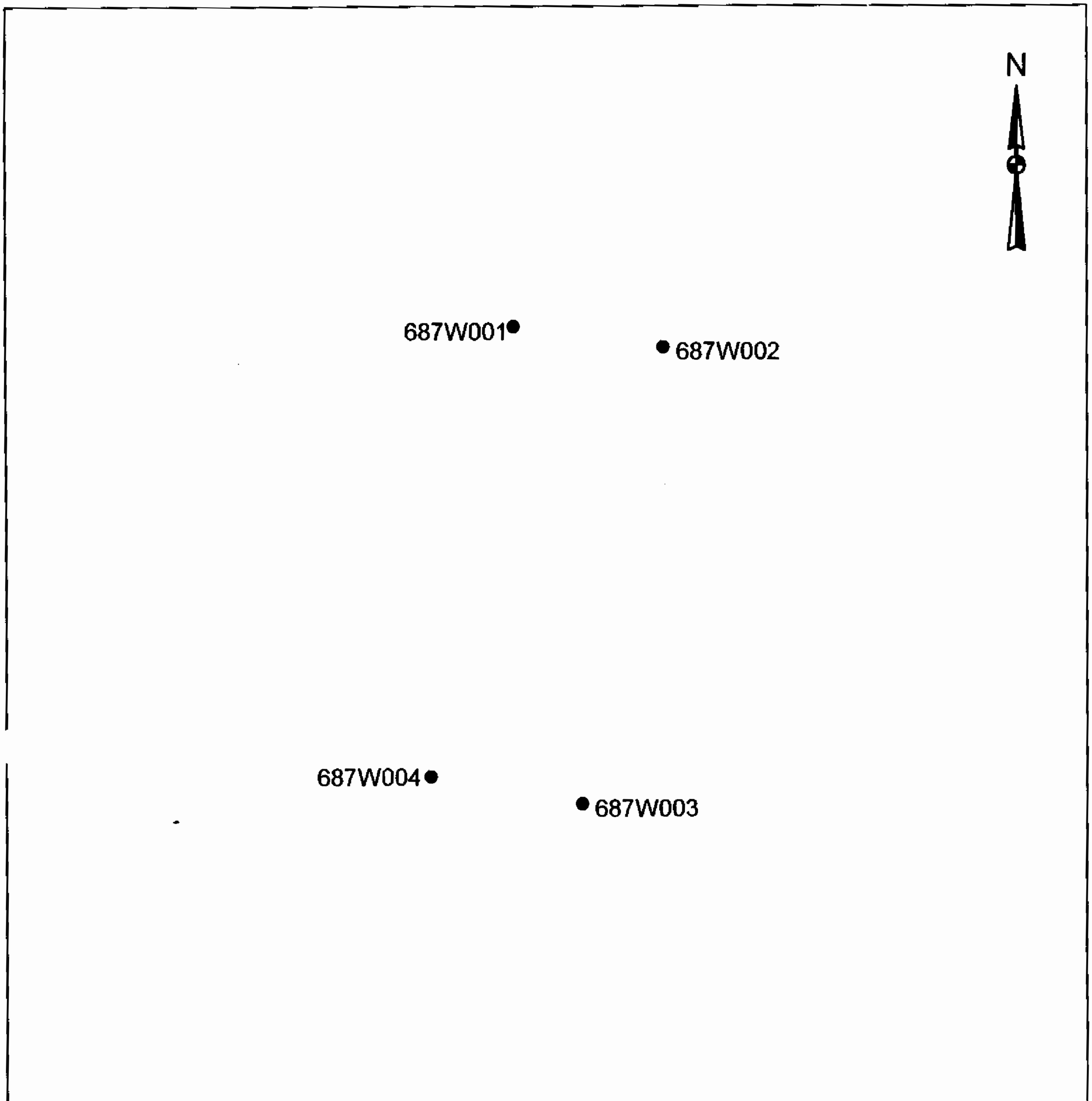
GROUNDWATER HAZARD INDEX
RESIDENTIAL SCENARIO

Table 10.8.32
Point Estimates of Risk and Hazard - Groundwater Pathways
Site Worker Scenario
AOC 687 and SWMU 16
Charleston Naval Complex
Charleston, South Carolina

AOC	Location	Round	Parameter	Concentration	Units	Hazard Index	Risk (E-06)
687	W001	01	Arsenic (As)	38.6	ug/L	2.518	404.67
687	W001	02	No COPCs			NA	NA
687	W001	03	No COPCs			NA	NA
687	W001	04	Thallium (Tl)	5.2	ug/L	1.272	NA
687	W001	05	No COPCs			NA	NA
687	W001	06	Arsenic (As)	3.3	ug/L	0.215	34.60
687	W001	06	Chromium (Cr)	20.9	ug/L	0.082	NA
			Total			0.297	34.60
687	W002	01	Arsenic (As)	33.2	ug/L	2.166	348.06
687	W002	01	Methylene chloride	15	ug/L	0.005	0.87
687	W002	01	Chromium (Cr)	2.1	ug/L	0.008	NA
			Total			2.179	348.93
687	W002	02	Arsenic (As)	73.7	ug/L	4.808	772.64
687	W002	03	No COPCs			NA	NA
687	W002	04	Arsenic (As)	39.3	ug/L	2.564	412.01
687	W002	04	Thallium (Tl)	2.7	ug/L	0.660	NA
			Total			3.224	412.01
687	W002	05	Arsenic (As)	131	ug/L	8.545	1373.36
687	W002	06	Arsenic (As)	58.3	ug/L	3.803	611.20
687	W002	06	Chromium (Cr)	12.7	ug/L	0.050	NA
			Total			3.853	611.20
687	W003	01	Methylene chloride	2	ug/L	0.001	0.12
687	W003	01	Chromium (Cr)	4.6	ug/L	0.018	NA
			Total			0.019	0.12
687	W003	02	No COPCs			NA	NA
687	W003	03	Arsenic (As)	5.6	ug/L	0.365	58.71
687	W003	03	Chromium (Cr)	1.7	ug/L	0.007	NA
			Total			0.372	58.71

Table 10.8.32
Point Estimates of Risk and Hazard - Groundwater Pathways
Site Worker Scenario
AOC 687 and SWMU 16
Charleston Naval Complex
Charleston, South Carolina

AOC	Location	Round	Parameter	Concentration	Units	Hazard Index	Risk (E-06)
687	W003	04	No COPCs			NA	NA
687	W003	05	Arsenic (As)	4.1	ug/L	0.267	42.98
687	W003	06	Arsenic (As)	4.3	ug/L	0.280	45.08
687	W003	06	Chromium (Cr)	20.7	ug/L	0.081	NA
			Total			0.362	45.08
687	W004	01	Arsenic (As)	6.3	ug/L	0.411	66.05
687	W004	01	Chromium (Cr)	1.5	ug/L	0.006	NA
			Total			0.417	66.05
687	W004	02	No COPCs			NA	NA
687	W004	03	No COPCs			NA	NA
687	W004	04	No COPCs			NA	NA
687	W004	05	Arsenic (As)	8.2	ug/L	0.535	85.97
687	W004	06	Arsenic (As)	3.3	ug/L	0.215	34.60
687	W004	06	Chromium (Cr)	26.1	ug/L	0.102	NA
			Total			0.317	34.60



LEGEND

- NO COPCs
- < 1E-6
- 1E-6 to 5E-6
- 5E-6 to 1E-5
- 1E-5 to 1E-4
- > 1E-4

40 0 40 80 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.8.15
ZONE I
AOC 687

GROUNDWATER POINT RISK
INDUSTRIAL SCENARIO

Arsenic was the primary contributor to hazard estimates, while methylene chloride, chromium, and thallium were secondary contributors. Figure 10.8.16 illustrates point hazard estimates for groundwater for the industrial scenario. Hazard estimates ranged from 0.001 (68700301) to 9 (68700205), with a mean hazard index of 1.

10.8.8.8 Remedial Goal Options

Surface Soil/Sediment

RGOs for carcinogens were based on the lifetime-weighted average site resident as presented in Table 10.8.33 for surface soil and sediment. Hazard-based RGOs were calculated based on the hypothetical child resident.

Groundwater

Groundwater RGOs based on site residents and site workers are shown in Table 10.8.34.

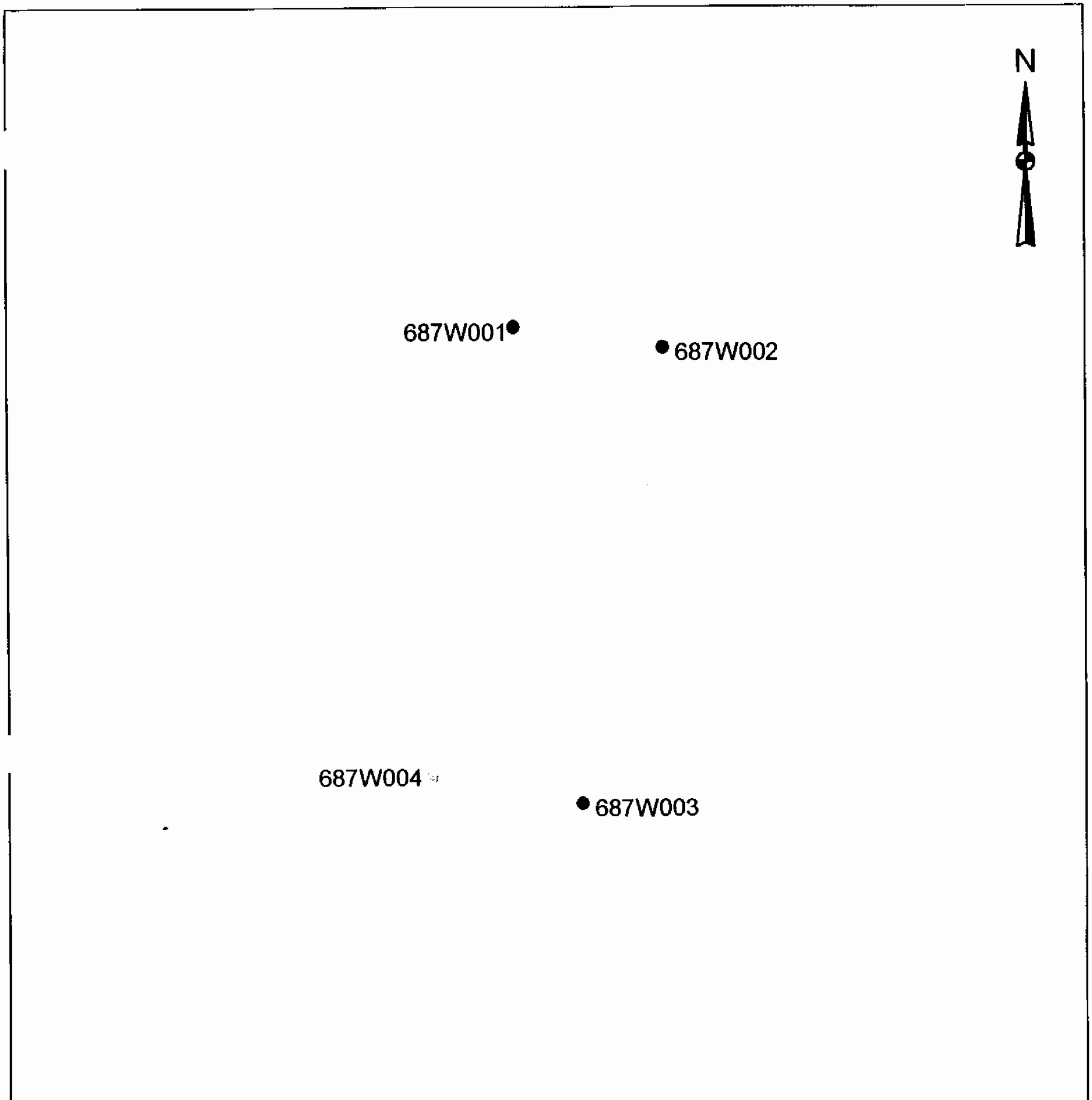
10.8.9 Corrective Measures Study (CMS)

Based on the analytical results and the human health risk assessment for AOC 687 and SWMU 16, COCs requiring further evaluation through the CMS process have been identified for surface soil and groundwater. The site is currently in a moderately developed urban setting and risk to human health was evaluated under both the residential and industrial (site worker) scenarios. For these scenarios, the incidental ingestion and dermal contact exposure pathways were evaluated. Hazard was evaluated for noncarcinogenic contaminants through incidental ingestion and dermal contact scenarios as well.

As recommended by SCDHEC, a COC is considered to be any chemical contributing to a cumulative risk level of 1E-06 or greater and/or a cumulative hazard index above 1.0, if its individual risk exceeds 1E-06 or its hazard quotient exceeds 0.1.

BEQs, chlordane, and chromium were identified as soil pathway COCs for AOC 687 and SWMU 16. Arsenic, chromium, methylene chloride, and thallium were identified as the groundwater COCs. Table 10.8.35 presents cumulative and COC-specific exposure risks and hazard quotients.

Risk-based remedial goals for surface soil and groundwater were presented in Tables 10.8.33 and 10.8.34. Potential corrective measures for soil are presented in Table 10.8.36.



LEGEND

- NO COPCs
- 0 to 0.1
- 0.1 to 0.5
- 0.5 to 1.0
- 1.0 to 3.0
- > 3.0

40 0 40 80 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.8.16
ZONE I
AOC 687

GROUNDWATER HAZARD INDEX
INDUSTRIAL SCENARIO

Table 10.8.33
Remedial Goal Options for Surface Soil and Sediment
SWMU 16 and AOC 687
Charleston Naval Complex
Charleston, South Carolina

Residential-Based Remedial Goal Options for Surface Soil and Sediment

Chemical	Oral Slope Factor (mg/kg-day)$^{-1}$	Oral Reference Dose (mg/kg-day)	EPC mg/kg	Hazard-Based Remedial Goal Options **3** mg/kg	**1** mg/kg	**0.1** mg/kg	Risk-Based Remedial Goal Options **1E-06** mg/kg	**1E-05** mg/kg	**1E-04** mg/kg	Background Concentration mg/kg
Benzo(a)pyrene Equivalents	7.3	NA	1.31	ND	ND	ND	0.06	0.6	6	ND
Chlordane	0.35	0.0005	5.25	90.9	30.3	3.03	1.26	12.6	126	ND
Chromium	NA	0.005	40.3	1093.9	365	36.46	ND	ND	ND	34.5

Notes:
EPC Exposure point concentration
NA Not applicable
ND Not determined
- Remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident for noncarcinogens.

Worker-Based Remedial Goal Options for Surface Soil and Sediment

Chemical	Oral Slope Factor (mg/kg-day)$^{-1}$	Oral Reference Dose (mg/kg-day)	EPC mg/kg	Hazard-Based Remedial Goal Options **3** mg/kg	**1** mg/kg	**0.1** mg/kg	Risk-Based Remedial Goal Options **1E-06** mg/kg	**1E-05** mg/kg	**1E-04** mg/kg	Background Concentration mg/kg
Benzo(a)pyrene Equivalents	7.3	NA	1.31	ND	ND	ND	0.30	2.97	29.7	ND

Notes:
EPC Exposure point concentration
NA Not applicable
ND Not determined
- Remedial goal options were based on the site worker for both carcinogens and noncarcinogens.

Table 10.8.34
Remedial Goal Options for Groundwater
SWMU 16 and AOC 687
Charleston Naval Complex
Charleston, South Carolina

Residential-Based Remedial Goal Options Shallow Groundwater

Chemical	Oral SF $(mg/kg\text{-}day)^{-1}$	Oral RfD (mg/kg-day)	EPC mg/L	Hazard-Based Remedial Goal Options 0.1 mg/L	1.0 mg/L	3 mg/L	Risk-Based Remedial Goal Options 1E-06 mg/L	1E-05 mg/L	1E-04 mg/L	MCL mg/L	Background Concentration mg/L
Arsenic	1.5	0.0003	0.056	0.00047	0.0047	0.0141	0.000044	0.00044	0.0044	0.05	0.023
Thallium	NA	0.00007	0.0027	0.00011	0.0011	0.0033	ND	ND	ND	0.002	0.002
Chromium	NA	0.005	0.0082	0.0078	0.078	0.23	ND	ND	ND	0.1	0.0143

Notes:
EPC Exposure point concentration
NA Not applicable
ND Not determined

Worker-Based Remedial Goal Options Shallow Groundwater

Chemical	Oral SF $(mg/kg\text{-}day)^{-1}$	Oral RfD (mg/kg-day)	EPC mg/L	**Hazard-Based Remedial Goal Options** **0.1** mg/L	**1.0** mg/L	**3** mg/L	**Risk-Based Remedial Goal Options** **1E-06** mg/L	**1E-05** mg/L	**1E-04** mg/L	MCL mg/L	Background Concentration mg/L
Arsenic	1.5	0.0003	0.056	0.0031	0.031	0.092	0.00019	0.0019	0.019	0.05	0.023
Thallium	NA	7E-05	0.0027	0.00072	0.0072	0.021	ND	ND	ND	0.002	0.002

Notes:
EPC Exposure point concentration
NA Not applicable
ND Not determined
- Remedial goal options were based on the residential lifetime-weighted average for carcinogens and the child resident for noncarcinogens

Table 10.8.35
AOC 687/SWMU 16
Cumulative and Chemical-Specific Exposure Risks and Hazard

	Risk		Hazard	
Chemical	**Industrial**	**Residential**	**Industrial**	**Residential**
Soil				
BEQs	4.4E-6	2.2E-5	ND	ND
Chlordane	8.5E-7	4.2E-6	0.0135	0.17
Chromium	ND	ND	0.0055	0.11
Cumulative	5.25E-6	2.6E-5	0.019	0.28
Groundwater				
Arsenic	3.0E-4	1.3E-3	1.8	12
Chromium	ND	ND	0.016	0.10
Methylene Chloride	1.71E-7	7.4E-7	0.0009	0.006
Thallium	ND	ND	0.38	2.5
Cumulative	3.0E-4	1.3E-3	2.2	14.6

Note:
ND = Not Detected

Table 10.8.36
AOC 687/SWMU 16
Potential Corrective Measures

Medium	Compounds	Potential Corrective Measures
Soil	BEQs, Chlordane, Chromium	a) No action b) Excavate, offsite disposal, and monitoring c) Containment/capping
Groundwater	Arsenic, Chromium, Methylene Chloride, Thallium	a) No action b) Monitoring c) Ex-situ physical/chemical treatment and discharge to POTW d) Ex-situ physical/chemical treatment and discharge through NPDES permitting

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10.9 AOC 688 (Ammunition Storage Bunker) Building X-56

AOC 688, an earth covered ammunition storage bunker identified as Building X-56, was constructed in 1942 as an ammunition storage magazine. The concrete walls and roof of the structure are 4 feet thick. The structure is completely covered by approximately 2 feet of soil. Immediately north of the magazine itself is a cement and soil containment berm designed to control the metal doors of the bunker in the event of an explosion. The area is surrounded by a chain-link fence. This AOC is located between Juneau Avenue and the Dredged Materials Area. The Cooper River and associated wetlands lie east of the site across Juneau Avenue.

The AOC, which was used originally as an ammunition bunker for an unknown period of time, was used as a lawnmower maintenance shop until approximately 1989, when it was again used for ammunition storage. A July 1989 environmental incident report documented the removal of five 55-gallon drums of paint contaminated soil and rags from the entrance to the facility. During the 1993 RFA 16 pounds of nitrogen based dynamite and 1,000 pounds of ammunition were stored in the bunker.

Materials of concern are explosives and paint waste. Activities associated with the site are limited to storage of ammunition and explosives, paint and paint related materials, and lawn equipment maintenance. Potential receptors would likely be workers involved with any invasive activity. The Cooper River and adjacent wetlands are also potential ecological receptors.

To fulfill CSI objectives, sediments were sampled in accordance with the final RFI work plan and Section 3 of this report. Soil samples not proposed in work plan were collected in accordance with Section 3.

10.9.1 Soil Sampling and Analysis

Soil was sampled in one round at AOC 688 in April 1998 at the locations shown on Figure 10.9.1. The final Zone I RFI work plan did not propose soil sampling; however, these samples were added at locations upgradient and downgradient from the original sediment sample points within the ditch. Because the ditch only contains water intermittently, these samples are more indicative of soil than sediment One upper- and lower-interval sample were collected from each boring. Samples were submitted for metals, pesticides, and PCBs analysis at DQO Level III. Table 10.9.1 summarizes the soil sampling at AOC 688.

Table 10.9.1
AOC 688
Soil Sampling Summary

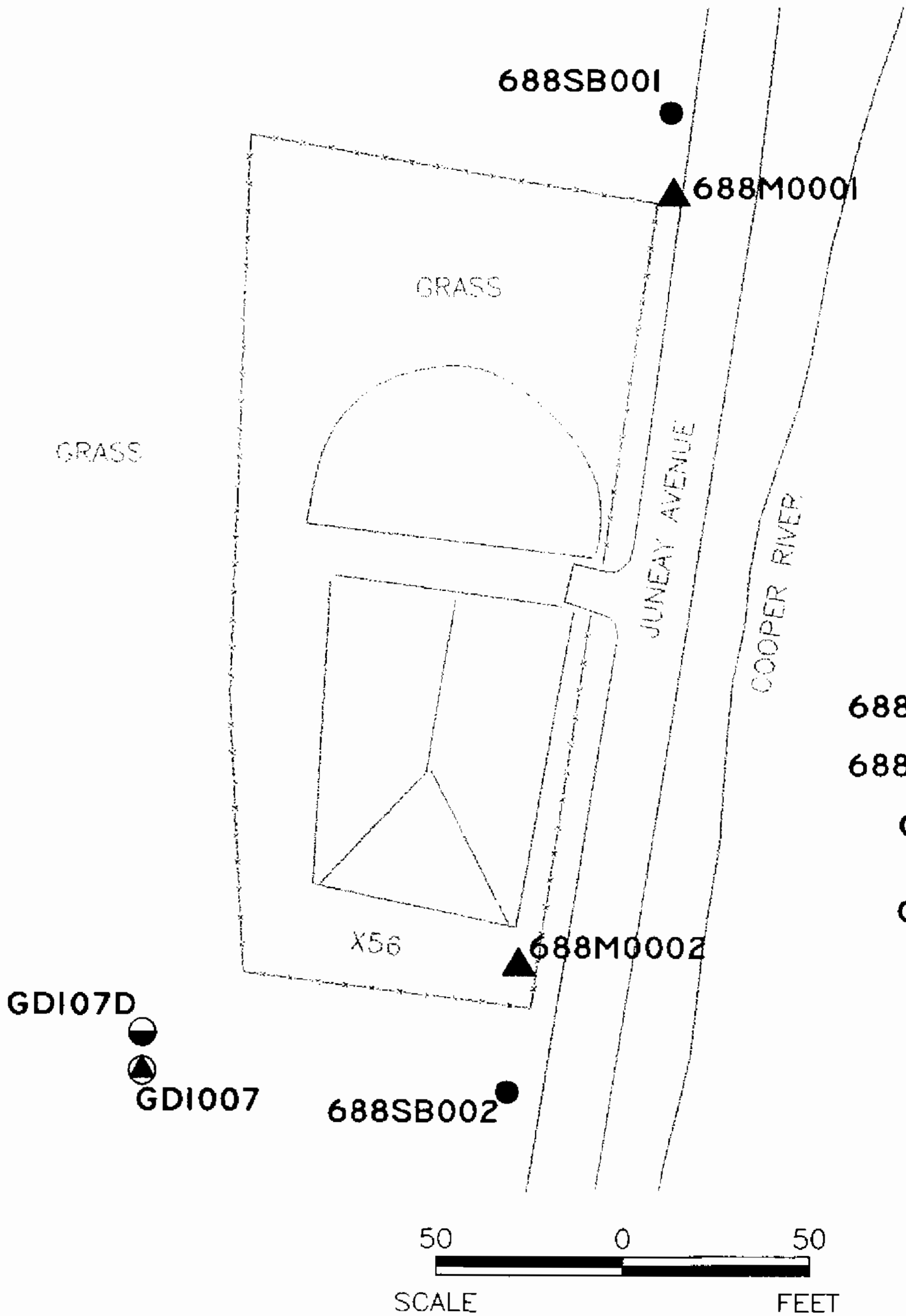
Sampling Round	Sampling Date	Samples Collected	Sample Analyses	Comments
1	04/02/98	Upper - 2 (0)	Metals, Pesticides and PCBs	Not part of the work plan
		Lower - 2 (0)	Metals, Pesticides and PCBs	

Note:
( ) = Parentheses indicate number of samples proposed.

Grid-based soil boring (GDI007) was advanced in the area of AOC 688 as shown in Figure 10.9.1. Upper-interval samples from this boring were analyzed for the standard suite of parameters. No lower-interval samples were collected from this boring. Results of sample analyses are presented in the nature and extent discussion of the combined sites and presented in Appendix D.

10.9.2 Nature and Extent of Contamination in Soil

Organic compound analytical data for soil are summarized in Table 10.9.2. Table 10.9.3 summarizes inorganic results. Table 10.9.4 summarizes analytes detected in surface and subsurface soil at AOC 688. Appendix D contains a complete analytical report for all samples collected in Zone I.



LEGEND:

688SB002 ● SOIL SAMPLE W/ ID NUMBER

688M0002 ▲ SEDIMENT SAMPLE W/ ID NUMBER

GDI007 SHALLOW MONITORING WELL W/ ID NUMBER

GDI07D DEEP MONITORING WELL W/ ID NUMBER

ZONE I
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.9.1
AOC 688
SAMPLING LOCATIONS

DWG DATE: 02/12/99 | DWG NAME: 2909G007

Table 10.9.2
AOC 688
Organic Compound Analytical Results for Soil(μg/kg)

Parameters	Sample Interval	Detection Frequency	Detection Range	Mean	RBC (upper) SSL (lower)	Number of Samples Exceeding RBC or SSL
Pesticides and PCBs						
4,4'-DDD	Upper	2/2	1.8 - 2.7	2.3	2,700	0
	Lower	2/2	5.9 - 28.0	17.0	8,000	0
4,4'-DDE	Upper	2/2	6.7 - 23.0	14.9	1,900	0
	Lower	2/2	12.0 - 74.0	43.0	27,000	0
4,4'-DDT	Upper	2/2	2.1 - 5.2	3.7	1,900	0
	Lower	0/2	ND	ND	16,000	0
Heptachlor Epoxide	Upper	2/2	0.94 - 5.7	3.3	70	0
	Lower	1/2	0.91	0.91	330	0
beta-BHC	Upper	1/2	0.32	0.32	350	0
	Lower	0/2	ND	ND	1.3	0
delta-BHC	Upper	0/2	ND	ND	350	0
	Lower	1/2	0.48	0.48	1.8	0
gamma-BHC	Upper	1/2	0.34	0.34	490	0
	Lower	0/2	ND	ND	4.5	0

Notes:
μg/kg = micrograms per kilogram
ND = Not Detected/Not Determined
See Table 5.5 for organic compound screening concentrations and their sources.

Table 10.9.3
AOC 688
Inorganic Analytical Results for Soil (mg/kg)

Parameter	Sample Interval	Detection Frequency	Detection Range	Mean	Background	RBC (upper) SSL (lower)	Number of Samples Exceeding RBC and Background (upper) or SSL and Background (lower)
Aluminum (Al)	Upper	2/2	10,400 - 12,600	11,500	27,400	7,800	0
	Lower	2/2	7,760 - 10,600	9,180	18,900	560,000	0
Arsenic (As)	Upper	2/2	5.6 - 9.8	7.7	21.6	0.43	0
	Lower	2/2	5.7 - 7.2	6.5	6.45	15	0
Barium (Ba)	Upper	2/2	20.6 - 24.2	22.4	54.2	550	0
	Lower	2/2	15.3 - 20.7	18.0	36	820	0
Beryllium (Be)	Upper	1/2	0.65	0.65	0.95	16	0
	Lower	1/2	0.55	0.55	0.67	32	0
Cadmium (Cd)	Upper	0/2	ND	ND	0.61	7.8	0
	Lower	1/2	0.47	0.47	0.54	4	0
Calcium (Ca)	Upper	2/2	23,300 - 129,000	76,150	NL	NL	NA
	Lower	2/2	70,000 - 104,000	87,000	NL	NL	NA
Chromium (Cr)	Upper	2/2	25.4 - 31.1	28.3	34.5	39	0
	Lower	2/2	15.1 - 34.1	24.6	51.3	19	0
Cobalt (Co)	Upper	2/2	2.7 - 4.0	3.4	5.8	470	0
	Lower	2/2	2.0 - 2.6	2.3	3.48	990	0
Copper (Cu)	Upper	2/2	11.5 - 20.2	15.6	240	310	0
	Lower	2/2	14.6 - 22.4	18.5	11.5	5,600	0
Iron (Fe)	Upper	2/2	11,400 - 13,800	12,600	NL	NL	NA
	Lower	2/2	8,410 - 8,680	8,550	NL	NL	NA
Lead (Pb)	Upper	2/2	17.3 - 25.2	21.3	203	400	0
	Lower	2/2	13.0 - 30.2	21.6	12.3	400	0
Magnesium (Mg)	Upper	2/2	2,020 - 4,810	3,420	NL	NL	NA
	Lower	2/2	1,590 - 5,280	3,440	NL	NL	NA

Table 10.9.3
AOC 688
Inorganic Analytical Results for Soil (mg/kg)

Parameter	Sample Interval	Detection Frequency	Detection Range	Mean	Background	RBC (upper) SSL (lower)	Number of Samples Exceeding RBC and Background (upper) or SSL and Background (lower)
Manganese (Mn)	Upper	2/2	195 - 588	392	419	160	1
	Lower	2/2	92.8 - 123	108	118	480	0
Mercury (Hg)	Upper	2/2	0.07 - 0.08	0.075	0.47	2.3	0
	Lower	2/2	0.05 - 0.17	0.11	ND	1	0
Nickel (Ni)	Upper	2/2	12.4 - 12.4	12.4	23.9	160	0
	Lower	2/2	7.2 - 12.8	10	15.7	65	0
Potassium (K)	Upper	2/2	853 - 1,230	1,042	NL	NL	NA
	Lower	2/2	493 - 1,120	807	NL	NL	NA
Selenium (Se)	Upper	0/2	ND	ND	1.49	39	0
	Lower	1/2	1.0	1.0	1.77	2.6	0
Sodium (Na)	Upper	2/2	196 - 468	332	NL	NL	NA
	Lower	2/2	146 - 1,300	723	NL	NL	NA
Vanadium (V)	Upper	2/2	27.0 - 29.8	28.4	113	55	0
	Lower	2/2	17.2 - 26.9	22.1	38.1	3,000	0
Zinc (Zn)	Upper	2/2	50.0 - 84.2	67.1	206	2,300	0
	Lower	2/2	33.5 - 63.3	48.4	36.2	6,200	0

Notes:
NA = Not Applicable/Not Available/Not Analyzed
ND = Not Detected/Not Determined
NL = Not Listed
mg/kg = milligrams per kilogram
See Table 5.6 for inorganic element screening concentrations and their sources.

Table 10.9.4
AOC 688
Analytes Detected in Surface Soil, Subsurface Soil, and Sediment

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Volatile Organic Compounds (μg/kg)							
2-Butanone (MEK)	688M0001	2	4700000	NA	NT	3900	NA
Pesticides/PCBs (μg/kg)							
Aldrin	688M0001	0.068	38	NA	NT	230	NA
	688M0002	0.12			NT		
Aroclor-1260	688M0001	98	320	NA	NT	1000	NA
beta-BHC (beta-HCH)	688SB001	0.32	350	NA	ND	1.3	NA
delta-BHC (delta-HCH)	688M0001	0.77	350	NA	NT	1.8	NA
	688M0002	0.92			NT		
	688SB001	ND			0.48		
gamma-BHC (Lindane)	688M0001	2	490	NA	NT	4.5	NA
	688M0002	0.65			NT		
	688SB002	0.34			NT		
4,4'-DDD	688M0001	0.82	2700	NA	NT	8000	NA
	688M0002	1			NT		
	688SB001	1.8			5.9		
	688SB002	2.7			28		
4,4'-DDE	688M0001	13	1900	NA	NT	27000	NA
	688M0002	35			NT		
	688SB001	6.7			12		
	688SB002	23			74		

Table 10.9.4
AOC 688
Analytes Detected in Surface Soil, Subsurface Soil, and Sediment

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
4,4'-DDT	688M0001	3.4	1900	NA	NT	16000	NA
	688M0002	1			NT		
	688SB001	2.1			ND		
	688SB002	5.2			ND		
Dieldrin	688M0001	1.3	40	NA	NT	2	NA
	688M0002	1.1			NT		
Endosulfan I	688M0001	8.9	47000	NA	NT	9000	NA
Endosulfan II	688M0001	6.8	47000	NA	NT	9000	NA
	688M0002	4.7			NT		
Endosulfan sulfate	688M0002	0.47	47000	NA	NT	4600	NA
Endrin	688M0002	1.4	2300	NA	NT	500	NA
Endrin aldehyde	688M0001	5	2300	NA	NT	340	NA
	688M0002	2.9			NT		
Heptachlor	688M0002	0.17	140	NA	NT	11000	NA
Heptachlor epoxide	688M0001	0.59	70	NA	NT	330	NA
	688M0002	0.56			NT		
	688SB001	0.94			0.91		
	688SB002	5.7			ND		
Methoxychlor	688M0002	4	39000	NA	NT	80000	NA

Table 10.9.4
AOC 688
Analytes Detected in Surface Soil, Subsurface Soil, and Sediment

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Inorganics (mg/kg)							
Aluminum (Al)	688M0001	5240	7800	27400	NT	560000	18900
	688M0002	6040			NT		
	688SB001	10400			7760		
	688SB002	12600			10600		
Antimony (Sb)	688M0001	0.3	3.1	ND	NT	2.7	ND
	688M0002	0.36			NT		
Arsenic (As)	688M0001	2.9	0.43	21.6	NT	15	6.45
	688M0002	3.8			NT		
	688SB001	5.6			5.7		
	688SB002	9.8			7.2		
Barium (Ba)	688M0001	13.3	550	54.2	NT	820	36
	688M0002	14.1			NT		
	688SB001	20.6			15.3		
	688SB002	24.2			20.7		
Beryllium (Be)	688SB002	0.65	16	0.95	0.55	32	0.67
Cadmium (Cd)	688SB002	ND	7.8	0.61	0.47	4	0.54
Chromium (Cr) (total)	688M0001	14.5	39	34.5	NT	19	51.3
	688M0002	15.8			NT		
	688SB001	25.4			15.1		
	688SB002	31.1			34.1		

Table 10.9.4
AOC 688
Analytes Detected in Surface Soil, Subsurface Soil, and Sediment

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Cobalt (Co)	688M0001	1.5	470	5.8	NT	990	3.48
	688M0002	2			NT		
	688SB001	2.7			2		
	688SB002	4			2.6		
Copper (Cu)	688M0001	10.7	310	240	NT	5600	11.5
	688M0002	8.3			NT		
	688SB001	20.2			14.6		
	688SB002	11.5			22.4		
Lead (Pb)	688M0001	12.5	400	203	NT	400	12.3
	688M0002	14.3			NT		
	688SB001	25.2			13		
	688SB002	17.3			30.2		
Manganese (Mn)	688M0001	143	160	419	NT	480	118
	688M0002	196			NT		
	688SB001	195			92.8		
	688SB002	588			123		
Mercury (Hg)	688SB001	0.08	2.3	0.47	0.05	1	ND
	688SB002	0.07			0.17		

Table 10.9.4
AOC 688
Analytes Detected in Surface Soil, Subsurface Soil, and Sediment

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Nickel (Ni)	688M0001	5.4	160	23.9	NT	65	15.7
	688M0002	8.3			NT		
	688SB001	12.4			7.2		
	688SB002	12.4			12.8		
Selenium (Se)	688SB002	ND	39	1.49	1	2.6	1.77
Tin (Sn)	688M0001	1.7	4700	7.5	NT	5500	ND
	688M0002	1.7			NT		
Vanadium (V)	688SB001	27	55	113	17.2	3000	38.1
	688SB002	29.8			26.9		
Zinc (Zn)	688M0001	230	2300	206	NT	6200	36.2
	688M0002	68.1			NT		
	688SB001	50			33.5		
	688SB002	84.2			63.3		

Notes:

*	=	Residential RBCs (THQ=0.1) were used as a reference concentration for upper-interval samples. Generic soil-to groundwater SSLs (DAF=10) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996b) were used as a reference concentration for lower-interval samples.

Bold concentrations exceed both the RBC and the zone background.
All background values for Zone I are based on twice the means of the grid sample concentrations. Background values for the groundwater are based on two sampling rounds in two wells at each depth.

GW	=	Groundwater
NA	=	Not applicable/not available
ND	=	Not detected
NT	=	Not taken
RBC	=	Risk-based concentration
SSL	=	Soil screening level
mg/kg	=	Micrograms per kilogram
THQ	=	Target Hazard Quotient
DAF	=	Dilution Attenuation Factor
μg/kg	=	Micrograms per kilogram

Volatile Organic Compounds in Soil

Toluene was detected in grid-based surface soil sample GDISB00701 at a concentration far below its RBC.

Semivolatile Organic Compounds in Soil

Three SVOCs were detected in grid-based surface soil sample GDISB00701: butylbenzylphthalate (98 μg/kg), benzo(b)fluoranthene (97 μg/kg), and benzo(k)fluoranthene (120 μg/kg). All concentrations were far below their RBCs.

Pesticides and PCBs in Soil

Seven pesticides were detected in surface and subsurface soil samples at concentrations far below their RBCs or SSLs: 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, Heptachlor Epoxide, beta-BHC, delta-BHC, and gamma-BHC.

Two pesticides were detected in grid-based surface soil sample GDISB00701 at concentrations far below their RBCs: endrin aldehyde (3.9 μg/kg) and chlordane (2.2 μg/kg).

The PCB Aroclor-1260 was also detected in surface soil sample GDISB00701 (23 μg/kg) at a concentration far below its RBC. Appendix D contains the complete analytical data report for all grid-based samples collected at Zone I.

Inorganics in Soil

Eighteen metals were detected in surface soil at AOC 688. Only manganese (588 mg/kg) exceeded its RBC and surface soil background concentration in sample 688SB00201. No other samples exceeded the RBC for surface soils. Twenty metals were detected in subsurface soil; however, no concentrations exceeded their SSLs and background values.

Nineteen metals were detected in grid-based surface soil sample GDISB00701. Chromium (47 mg/kg) exceeded its RBC and surface soil background concentration in this sample. All other metal concentrations in this sample were far below their RBCs and surface soil background values.

10.9.3 Nature and Extent of Contamination in Groundwater

No wells were proposed to be installed specifically for AOC 688 in the approved final RFI work plan. Groundwater samples were collected from a shallow/deep monitoring well pair (GDI007/GDI07D) near AOC 688. Both were sampled during six sampling events. During the first sampling round, these wells were sampled for chloride, cyanide, sulfate, metals, pesticides and PCBs, SVOCs, and VOCs. GDI00701 was also analyzed for TDS, while GDI07D01 was analyzed for organotins during the first sampling round. During the second, third, and fourth sampling round, these wells were sampled for chloride, cyanide, sulfate, metals, pesticides and PCBs, SVOCs, VOCs, and TDS. During the fifth sampling round, these wells were samples for metals and SVOCs. A duplicate sample (analyzed for metals and SVOCs) was also collected from GDI007 during the fifth sampling round. During the sixth sampling round these wells were sampled for metals, SVOCs and VOCs. A duplicate sample (analyzed for metals, VOCS, and SVOCs) was also collected from GDI07D during the sixth sampling round. Results of these analyses are discussed with the nature and extent of AOC 688 and are presented in Appendix D.

The shallow monitoring wells were installed at 12.5 ft bgs in the upper sand layer of the Wando Formation. Deep grid well GDI07D was installed at 44.4 feet bgs. All wells were installed in accordance with Section 3 of this report.

The complete analytical data report for all grid-based samples collected in Zone I is presented in Appendix D.

Volatile Organics in Groundwater

No VOCs were detected in shallow or deep groundwater samples from grid-based wells GDI007/GDI07D.

Semivolatile Compounds in Groundwater

No SVOCs were detected in shallow or deep groundwater samples from grid-based wells GDI007/GDI07D.

Pesticides and PCBs in Groundwater

No pesticides or PCBs were detected in shallow or deep groundwater samples from grid-based wells GDI007/GDI07D.

Inorganics in Groundwater

Eighteen metals were detected in groundwater samples from nearby shallow grid-based well GDI007. Lead (15.7 μg/L) exceeded its tap-water RBC, MCL, and shallow groundwater background concentration during the second sampling round at GDI007. All other metal concentrations at GDI007 were far below their tap-water RBCs, MCLs, and shallow groundwater background concentrations. Eighteen metals were detected at deep grid-based well GDI07D. All metal concentrations at GDI07D were far below their tap-water RBCs, MCLs, and deep groundwater background concentrations.

10.9.4 Sediment Sampling and Analysis

As proposed in the final Zone I RFI work plan, sediment was sampled at two locations shown on Figure 10.9.1. Samples 688M0001 and 688M0002 were collected in a drainage ditch east of Bunker X-56 that trends north-south. Because the ditch only contains water intermittently, these samples are more indicative of soil than sediment and will be compared to surface soil screening criteria. The purpose of these samples was to characterize potential contamination from surface water runoff within the site area. The two samples were analyzed for the standard suite (VOCs, SVOCs, metals, cyanide, pesticides and PCBs) at DQO Level III plus, TOC and grain size.

10.9.5 Nature and Extent of Contamination in Sediment

Table 10.9.4 summarizes analytes detected in sediments at AOC 688. Organic compound data for sediment are summarized in Table 10.9.5. Inorganic analytical data for sediment are summarized in Table 10.9.6. Appendix D contains a complete analytical data report for all samples collected in Zone I.

Volatile Organic Compounds in Sediment

The VOC 2-Butanone was detected in sample 688M000101 at a concentration of 2.0 μg/kg. This concentration is well below the listed RBC.

Semivolatile Organic Compounds in Sediment

No SVOCs were detected in sediments at AOC 688.

Pesticides and PCBs

Fifteen pesticides were detected in sediment samples at AOC 688. Most pesticide detections occurred in sample 688M000201, the downgradient location. All pesticide detections were below their listed RBCs.

The PCB Aroclor-1260 was detected in sample 688M000101 (98.0 μg/kg) far below its RBC (320 μg/kg). No other PCBs were detected in the upgradient soil sample or downgradient sediment and soil samples.

Table 10.9.5
AOC 688
Organic Compound Analytical Results for Sediment (μg/kg)

Parameters	Frequency of Detections	Range of Detection	Mean	RBCs	Number of Sample Exceeding RBCs
Volatile Organic Compounds					
2-Butanone	½	2.0	2.0	4,700,000	NA
Pesticides and PCBs					
4,4'-DDD	2/2	0.82 - 1.0	0.91	2,700	0
4,4'-DDE	2/2	13.0 - 35.0	24.0	1,900	0
4,4'-DDT	2/2	1.0 - 3.4	2.2	1,900	0
Aldrin	2/2	0.068 - 0.12	0.09	38	0
Dieldrin	2/2	1.1 - 1.3	1.2	40	0
Endosulfan I	1/2	8.9	8.9	47,000	0
Endosulfan II	2/2	4.7 - 6.8	5.75	47,000	0
Endosulfan sulfate	1/2	0.47	0.47	47,000	0
Endrin	1/2	1.4	1.4	2,300	0
Endrin aldehyde	2/2	2.9 - 5.0	3.95	2,300	0
Heptachlor	1/2	0.17	0.17	140	0
Heptachlor epoxide	2/2	0.56 - 0.59	0.575	70	0
Methoxychlor	1/2	4.0	4.0	39,000	0
delta-BHC	2/2	0.77 - 0.92	0.85	350	0
gamma-BHC	2/2	0.65 - 2.0	1.33	490	0
Aroclor-1260	1/2	98.0	98.0	320	0

Notes:
NL = Not Listed
NA = Not Applicable/Not Available/Not Analyzed
μg/kg = microgram per kilogram

Table 10.9.6
AOC 688
Inorganic Analytical Results for Sediment (mg/kg)

Parameters	Frequency of Detections	Range of Detection	Mean	Background Concentration	RBCs	Number of Samples Exceeding RBCs and Background
Inorganics						
Aluminum (Al)	2/2	5,240 - 6,040	5,640	27,400	7,800	0
Antimony (Sb)	2/2	0.3 - 0.36	0.33	ND	3.1	0
Arsenic (As)	2/2	2.9 - 3.8	3.4	21.6	.43	0
Barium (Ba)	2/2	13.3 - 14.1	13.7	54.2	550	0
Calcium (Ca)	2/2	128,000 - 167,000	147,500	NL	NL	NA
Chromium (Cr)	2/2	14.5 - 15.8	15.2	34.5	39	0
Cobalt (Co)	2/2	1.5 - 2.0	1.8	5.8	470	0
Copper (Cu)	2/2	8.3 - 10.7	9.5	240	310	0
Iron (Fe)	2/2	4,260 - 5,400	4,830	NL	NL	NA
Lead (Pb)	2/2	12.5 - 14.3	13.4	203	400	0
Magnesium (Mg)	2/2	1,850 - 2,570	2,210	NL	NL	NA
Manganese (Mn)	2/2	143 - 196	170	419	160	0
Nickel (Ni)	2/2	5.4 - 8.3	6.9	23.9	160	0
Potassium (K)	2/2	740 - 922	831	NL	NL	NA
Sodium (Na)	2/2	478 - 552	515	NL	NL	NA
Tin (Sn)	2/2	1.7 - 1.7	1.7	7.5	4,700	NA
Zinc (Zn)	2/2	68.1 - 230	149	206	2,300	0

Notes:
NA = Not Applicable
NL = Not Listed
mg/kg = milligram per kilogram

Inorganics in Sediment

Seventeen metals were detected in sediment samples at AOC 688. Each metal was found at both sample locations. All metal concentrations detected in sediment samples were far below their RBCs.

10.9.6 Fate and Transport Assessment for AOC 688

AOC 688, an earth-covered ammunition storage bunker identified as Building X-56 was constructed in 1942. It is located between Juneau Avenue and the Dredged Materials Area. The bunker reportedly was used once for the unauthorized storage of of paint in 1987. The bunker was also used as a lawnmower machine shop. Materials of concern are explosives and paint waste. Activities associated with the site are limited to storing small amounts of ammunition and explosives. Environmental media sampled as part of this investigation are surface and subsurface soil. Potential constituent migration pathways evaluated for AOC 688 are soil-to-groundwater, soil-to-sediment, and emission of volatiles from surface soil-to-air.

10.9.6.1 Soil-to-Groundwater Cross-Media Transport

Tables 10.9.7 and 10.9.8 compare maximum detected organic and inorganic constituent concentrations in surface and subsurface soil samples to risk-based soil screening levels considered protective of groundwater. Maximum concentrations in soil are compared to leachability-based generic SSLs. Soil background values for Zone I inorganics were determined, but at the request of SCDHEC, not considered during initial comparisons of maximum soil concentrations to SSLs. To provide a conservative screening, generic SSLs are used; leachate entering the aquifer is assumed to be diluted by a ratio of 10:1, with no attenuation of constituents in soil (DAF=10).

No organic constituents exceeded their SSLs in site soil. However, two inorganic parameters – chromium and manganese – exceeded soil SSLs. Chromium was detected in all samples, with the majority exceeding the SSL. However, all concentrations were below the zone-specific background. Figure 10.9.2 presents chromium detections at AOC 688. Similar to chromium, manganese was detected in all samples, but exceeded the SSL and zone-specific background in only one surface soil sample. Figure 10.9.3 presents manganese detections at AOC 688. Both constituents are commonly detected in zone soil at similar concentrations, thus it's unlikely the site is their source. Given the past site activities (namely, paint storage) chromium would be the only

Table 10.9.7
Organic Chemicals Detected in Surface Soil, Subsurface Soil, Sediment, and Shallow Groundwater
Comparison to Cross-Media SSLs, Tap-water RBCs, and Saltwater Surface Water Chronic Screening Levels
AOC 688
Charleston Naval Complex
Charleston, South Carolina

Parameter	Maximum Concentration: Surface Soil	Subsurface Soil	Sediment	Shallow GW	Screening Concentration: Soil to GW SSL	Soil to Air SSL	Tap-water RBC	Saltwater Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Volatilization Potential	Ground-water Migration Concern	Surface Water Migration Concern
Volatile Organic Compounds														
2-Butanone (MEK)	ND	ND	2	NA	3900 a	NA	1900	NA	µG/KG	µG/L	NO	NO	NO	NO
Pesticides/PCBs														
Aldrin c	ND	ND	0.12	NA	230	3000	0.0039	0.13	µG/KG	µG/L	NO	NO	NO	NO
Aroclor-1260 c	ND	ND	98	NA	1000	1000	0.033	0.03	µG/KG	µG/L	NO	NO	NO	NO
beta-BHC (beta-HCH) c	0.32	ND	ND	NA	1.3	1E+09	0.037	NA	µG/KG	µG/L	NO	NO	NO	NO
delta-BHC (delta-HCH) c	ND	0.48	0.92	NA	1.8 a	NA	0.037	NA	µG/KG	µG/L	NO	NO	NO	NO
gamma-BHC (Lindane) c	0.34	ND	2	NA	4.5	NA	0.052	0.016	µG/KG	µG/L	NO	NO	NO	NO
4,4'-DDD c	2.7	28	1	NA	8000	NA	0.28	0.025	µG/KG	µG/L	NO	NO	NO	NO
4,4'-DDE c	23	74	35	NA	27000	NA	0.2	0.14	µG/KG	µG/L	NO	NO	NO	NO
4,4'-DDT c	5.2	ND	3.4	NA	16000	1E+09	0.2	0.001	µG/KG	µG/L	NO	NO	NO	NO
Dieldrin c	ND	ND	1.3	NA	2	1000	0.0042	0.0019	µG/KG	µG/L	NO	NO	NO	NO
Endosulfan I	ND	ND	8.9	NA	9000 b	NA	220	0.0087	µG/KG	µG/L	NO	NO	NO	NO
Endosulfan II	ND	ND	6.8	NA	9000 b	NA	220	0.0087	µG/KG	µG/L	NO	NO	NO	NO
Endosulfan sulfate	ND	ND	0.47	NA	4600 a	NA	220	NA	µG/KG	µG/L	NO	NO	NO	NO
Endrin	ND	ND	1.4	NA	500	NA	11	0.0023	µG/KG	µG/L	NO	NO	NO	NO
Endrin aldehyde	ND	ND	5	NA	340 a	NA	11	NA	µG/KG	µG/L	NO	NO	NO	NO
Heptachlor c	ND	ND	0.17	NA	11000	100	0.0023	0.0036	µG/KG	µG/L	NO	NO	NO	NO
Heptachlor epoxide c	5.7	0.91	0.59	NA	330	5000	0.0012	0.0036	µG/KG	µG/L	NO	NO	NO	NO
Methoxychlor	ND	ND	4	NA	80000	NA	180	0.03	µG/KG	µG/L	NO	NO	NO	NO

Notes:
Sources of screening concentrations appear in Table 5.5.
Explanations of fate and transport screening procedures appear in Section 6.2.
Frequency and range of detections, average detected concentrations, and number of screening concentration exceedances appear in Tables 10.9.2 and 10.9.5.

a - Calculated soil to groundwater SSL value (See Table 6.2)
b - Based on surrogate compound; see Table 5.5
c - Carcinogenic
GW - Groundwater

NA - Not applicable/not available
ND - Not detected
RBC - Risk-based concentration
SSL - Soil screening level

µG/KG - Micrograms per kilogram
µG/L - Micrograms per liter

Table 10.9.8
Inorganic Chemicals Detected in Surface Soil, Subsurface Soil, Sediment, and Shallow Groundwater
Comparison to Cross-Media SSLs, Tap-water RBCs, Saltwater Surface Water Chronic Screening Levels, and Background Values
AOC 688
Charleston Naval Complex
Charleston, South Carolina

Parameter	Maximum Concentration				Screening Concentration											
	Surface Soil	Subsurface Soil	Sediment	Shallow GW	Soil to GW SSL	Soil Background	Soil to Air SSL	Tap Water RBC	Shallow GW Background	Saltwater Surf. Wtr Chronic	Soil Units	Water Units	Leaching Potential	Fugitive Particulate Inhalation Concern	Ground-water Migration Concern	Surface Water Migration Concern
Inorganic Chemicals																
Aluminum (Al)	12600	10600	6040	NA	560000 a	27400	NA	37000	1440	NA	MG/KG	µG/L	NO	NO	NO	NO
Antimony (Sb)	ND	ND	0.36	NA	2.7	ND	NA	15	NA	NA	MG/KG	µG/L	NO	NO	NO	NO
Arsenic (As) c	9.8	7.2	3.8	NA	15	21.6	750	0.045	23	36	MG/KG	µG/L	NO	NO	NO	NO
Barium (Ba)	24.2	20.7	14.1	NA	820	54.2	690000	2600	110	NA	MG/KG	µG/L	NO	NO	NO	NO
Beryllium (Be)	0.65	0.55	ND	NA	32	0.95	1300	73	1.1	NA	MG/KG	µG/L	NO	NO	NO	NO
Cadmium (Cd)	ND	0.47	ND	NA	4	0.61	1800	18	NA	9.3	MG/KG	µG/L	NO	NO	NO	NO
Chromium (Cr) (total)	31.1	34.1	15.8	NA	19	51.3	270	180	14.3	50	MG/KG	µG/L	YES	NO	NO	NO
Cobalt (Co)	4	2.6	2	NA	990 a	5.8	NA	2200	2.2	NA	MG/KG	µG/L	NO	NO	NO	NO
Copper (Cu)	20.2	22.4	10.7	NA	5600 a	240	NA	1500	4.4	2.9	MG/KG	µG/L	NO	NO	NO	NO
Lead (Pb)	25.2	30.2	14.3	NA	400	203	400	15	4.4	8.5	MG/KG	µG/L	NO	NO	NO	NO
Manganese (Mn)	588	123	196	NA	480 a	419	NA	730	5430	NA	MG/KG	µG/L	YES	NO	NO	NO
Mercury (Hg)	0.08	0.17	ND	NA	1	0.47	10	11	NA	0.025	MG/KG	µG/L	NO	NO	NO	NO
Nickel (Ni)	12.4	12.8	8.3	NA	65	23.9	13000	730	13.3	8.3	MG/KG	µG/L	NO	NO	NO	NO
Selenium (Se)	ND	1	ND	NA	2.6	1.77	NA	180	ND	71	MG/KG	µG/L	NO	NO	NO	NO
Tin (Sn)	ND	ND	1.7	NA	5500 a	7.5	NA	22000	NA	NA	MG/KG	µG/L	NO	NO	NO	NO
Vanadium (V)	29.8	26.9	ND	NA	3000	113	NA	260	14	NA	MG/KG	µG/L	NO	NO	NO	NO
Zinc (Zn)	84.2	63.3	230	NA	6200	206	NA	11000	24.4	86	MG/KG	µG/L	NO	NO	NO	NO

Notes:
Sources of screening concentrations appear in Table 5.6.
Explanations of fate and transport screening procedures appear in Section 6.2.
Frequency and range of detections, average detected concentrations, and number of screening concentration exceedances appear in Tables 10.9.3 and 10.9.6.

Background values for soil are shown for comparison purposes only.
Maximum groundwater concentrations are screened against the greater of tap water RBCs or corresponding background reference values to determine groundwater migration concern.

a - Calculated soil to groundwater SSL value (See Table 6.2)
c - Carcinogenic
GW - Groundwater

NA - Not available/Not applicable
ND - Not detected
RBC - Risk-based concentration

SSL - Soil screening level
MG/KG - Milligrams per kilogram
µG/L - Micrograms per liter

conceivable COC associated with the site, but the spatial distribution suggests otherwise. The absence of manganese above the SSL in subsurface soil suggests that the pathway for this constituent is not significant, while the pathway for chromium is considered valid. However, no detected concentrations exceeded background.

10.9.6.2 Soil-to-Sediment Cross-Media Transport

The organic constituents detected were notably different from those in site soil. Specifically, of the 16 detected in sediment, only five were also present in soil: those specific to sediment were pesticides. The inorganic constituents detected in sediment were similar to those present in soil. The presence of pesticides in sediment indicates that the drainage area sampled has been sprayed with pesticides and their detections are likely residual concentrations. The similarity of inorganics in soil and sediment indicates that site drainage could be the source for sediments and/or that the sediment is simply periodically inundated surface soil.

10.9.6.3 Soil-to-Air Transport

No VOCs were detected in surface soil above appropriate volatilization SSLs at this site, thus this pathway is considered invalid.

10.9.6.4 AOC 688 Fate and Transport Summary

AOC 688 is an earth-covered ammunition storage bunker constructed in 1942 between Juneau Avenue and the Dredged Materials Area. Materials of concern are explosives and paint waste. Environmental media sample as part of this investigation are surface and subsurface soil. Potential constituent migration pathways evaluated for AOC 688 are soil-to-groundwater, soil-to-sediment, and emission of volatiles from surface soil-to-air.

Soil-to-Groundwater Pathway

Two inorganic parameters – chromium and manganese – are present at levels exceeding their respective SSLs.

- Chromium was detected in all samples, generally exceeded the SSL, but was below background in all cases.
- Manganese was also present in all samples, but exceeded the SSL and background in only one surface soil sample.
- Both constituents are common in Zone I soils, and their presence and distribution on this site does not indicate the past site activities as their source.
- The absence of manganese at concentrations exceeding SSLs in subsurface soil lessens the significance of the pathway with respect to it. The presence of chromium above SSL in the subsurface indicates that the pathway is valid for chromium, although detected concentrations are consistent with zone-specific background.

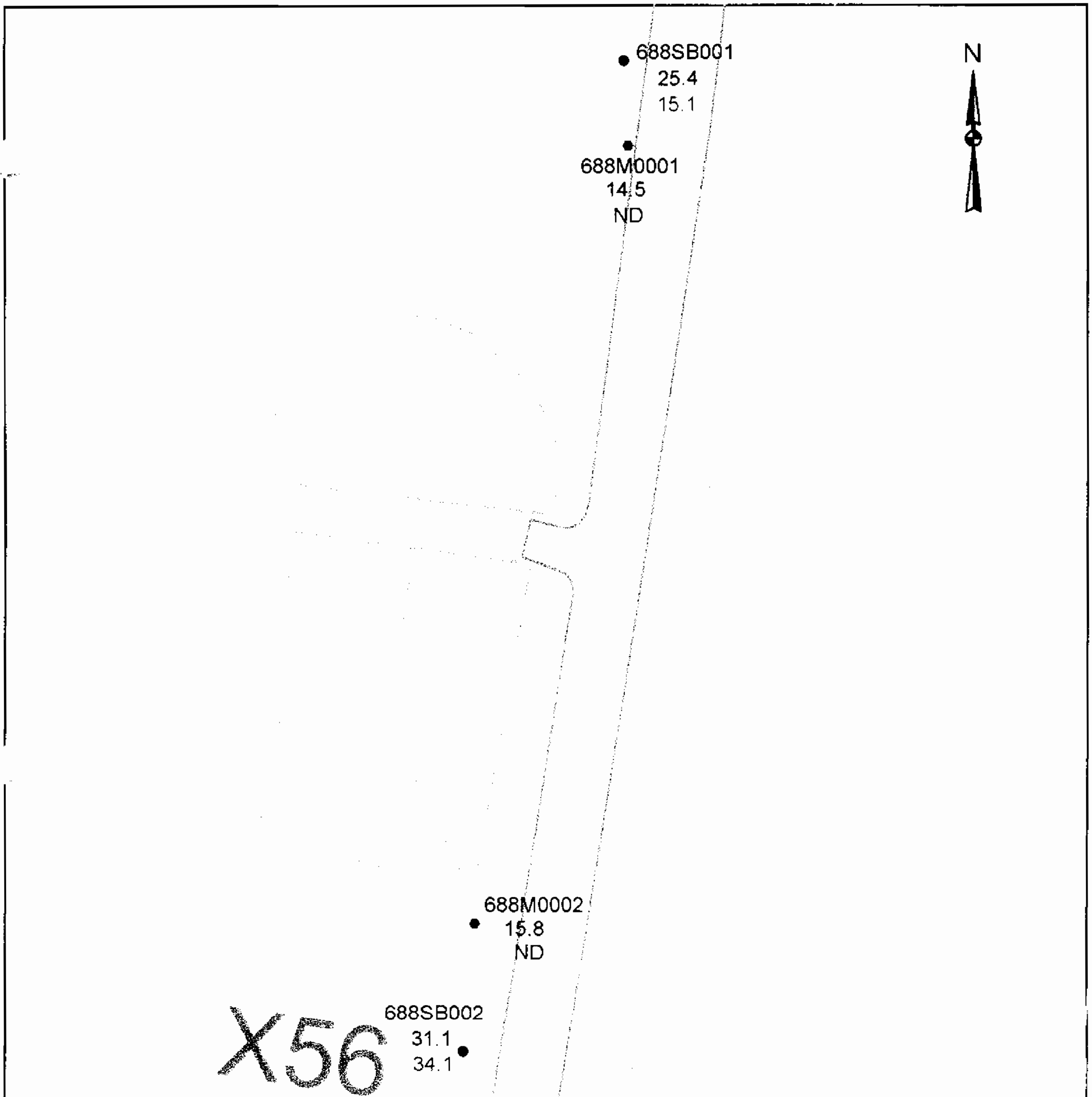
Soil-to-Sediment Pathway

Organic compounds detected in sediment are remarkably different from those detected in surface soil. The majority of species present in sediment are pesticides, and their presence is presumed to be a result of pesticide application along the access road near the drainage ditch.

The inorganic parameters detected in surface soil and sediment are similar, suggesting that entrained soil in runoff from the site may be the provenance for the sediment; alternatively, given the site setting, the sediment may simply be periodically inundated surface soil.

Soil-to-Air Pathway

No VOCs were detected above volatilization screening values, thus the pathway is considered invalid for this AOC.



LEGEND

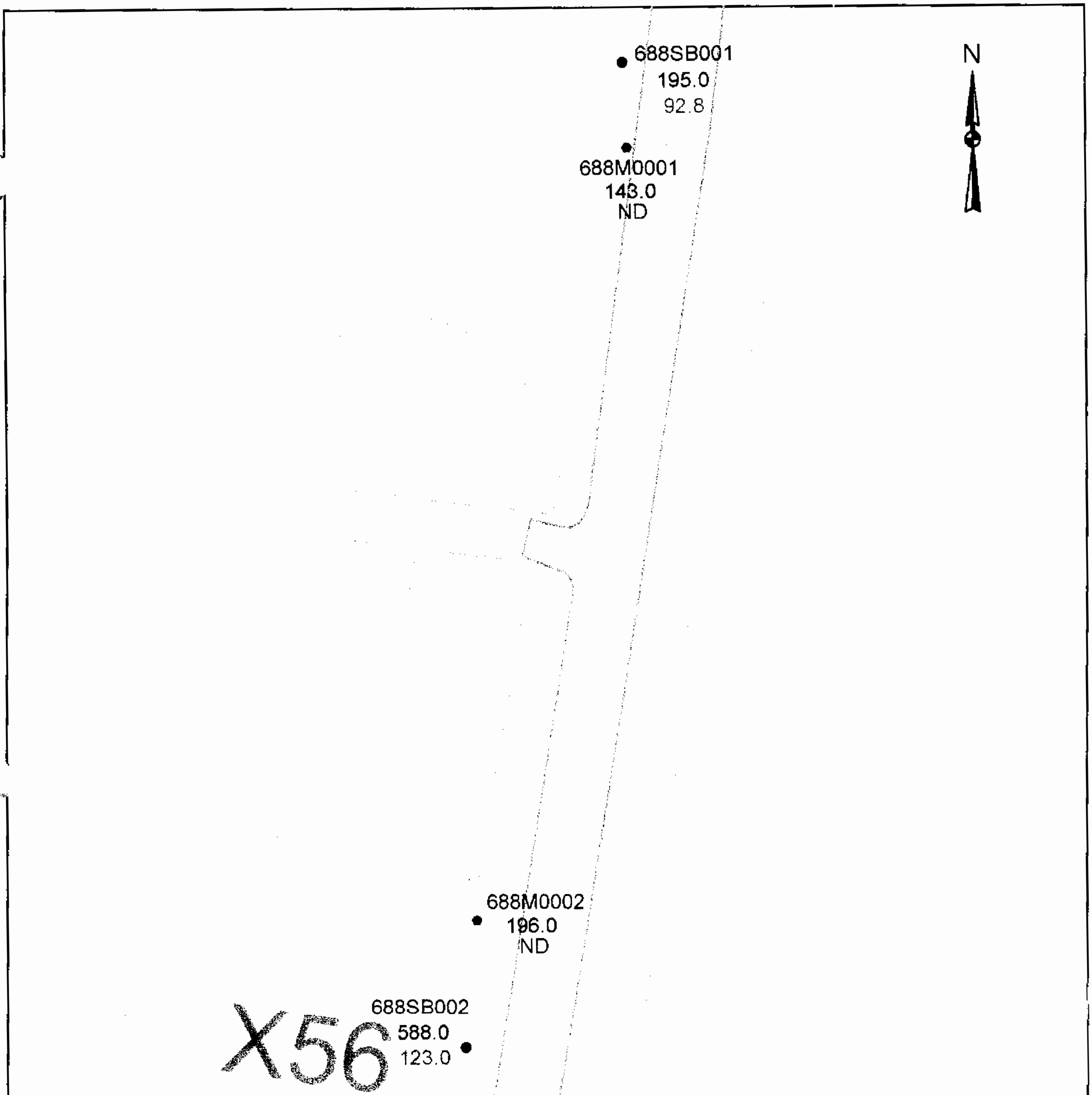
■ MONITORING WELL LOCATION
● ZONE I SOIL BORING LOCATION
12.30 ZONE I SURFACE SOIL CONC. (MG/KG)
12.30 ZONE I SUBSURFACE SOIL CONC. (MG/KG)
12.30 MAXIMUM QUARTERLY GW CONC. (UG/L)
NS NO SAMPLE TAKEN
ND NON DETECT

SCALE
20 0 20 40 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.9.2
ZONE I
AOC 688
CHROMIUM
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=100 UG/L RBC=39 MG/KG SSL=19 MG/KG



LEGEND

- ■ MONITORING WELL LOCATION
- ● ZONE I SOIL BORING LOCATION

12.30	ZONE I SURFACE SOIL CONC. (MG/KG)
12.30	ZONE I SUBSURFACE SOIL CONC. (MG/KG)
12.30	MAXIMUM QUARTERLY GW CONC. (UG/L)
NS	NO SAMPLE TAKEN
ND	NON DETECT

SCALE
20 0 20 40 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.9.3
ZONE I
AOC 688
MANGANESE
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=NA RBC=160 MG/KG SSL=480 MG/KG

10.9.7 Human Health Risk Assessment

10.9.7.1 Site Background and Investigative Approach

AOC 688 was investigated to assess surface soil and sediment potentially affected by past site activities. The earth covered ammunition storage bunker is located between Juneau Avenue and the Dredged Materials Area. The Cooper River and associated wetlands lie to the east of the site across Juneau Avenue. The structure was constructed in 1942 as a magazine for ammunition storage. The structure is completely covered by two feet of soil. Immediately north of the magazine itself is a cement and soil containment berm designed to control the metal doors in the event of an explosion. The area is surrounded by a chain link fence.

The facility functioned as an ammunition bunker for an unknown period of time. The facility was also used as a lawnmower maintenance shop. In July 1987 five fifty-five gallon drums of paint contaminated soil and rags were removed from the entrance to the facility and sent for disposal as hazardous waste. During the 1993 RFA 16 pounds of nitrogen based dynamite and 1000 pounds of gunpowder were stored in the bunker.

Two sediment samples were collected for analysis of VOCs, SVOCs, metals, cyanide, pesticides, PCBs, grain size, and TOC at DQO Level III. The samples were collected from a drainage ditch east of Bunker X-56 that trends north and south. Figure 10.9.1 shows sediment sampling locations. Soil was sampled in one round at AOC 688 at the locations as shown on Figure 10.9.1. The final Zone I RFI work plan did not propose soil sampling; however, these samples were added at locations upgradient and downgradient from the original sediment sample points within the ditch. Because the ditch only contains water intermittently, these samples are more indicative of soil than sediment. One upper and lower-interval sample was collected from each boring and submitted for metals, pesticides, and PCBs analysis at DQO Level III.

10.9.7.2 COPC Identification

Surface Soil/Sediment

Based on the screening comparisons described in Section 7 of this RFI and presented in Tables 10.9.9 and 10.9.10, manganese was identified as a COPC. Aluminum and arsenic were detected at maximum concentrations exceeding their RBCs; however, they did not exceed their corresponding background concentration. Therefore, these inorganics were eliminated from further consideration in the AOC 688 HHRA. The results of the Wilcoxon rank sum test analyses did not result in the inclusion of any inorganic parameters that had been screened out on the basis of background concentration comparisons.

10.9.7.3 Exposure Assessment

Exposure Setting

AOC 688 was investigated to assess surface soil and sediment potentially affected by past site activities. Current base reuse plans indicate that the area is slated for redevelopment as a marine cargo terminal although future use of this AOC is unknown. The site is surrounded by a fence, which inhibits access to potential trespassers. All potable water is provided through the city's water supply. Groundwater is not currently anticipated to be used in the future as potable or process water.

Potentially Exposed Populations

Potentially exposed populations are current and future site workers. Additional potentially exposed populations are hypothetical future site residents and adolescent trespassers (assuming the fence is removed under hypothetical future use scenarios). Future site resident and worker exposure scenarios were quantitatively addressed in this risk assessment. Current exposure to workers is discussed quantitatively in relation to the future workers and future residents. The hypothetical future site worker scenario assumed continuous exposure to surface soil and sediment.

Table 10.9.9
Chemicals Present in Site Samples
AOC 688 - Surface Soil
Charleston Naval Complex
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration Residential RBC	Background	Units	Number Exceeding RBC	Background
Inorganics													
Aluminum (Al)		2	2	10400	12600	11500	NA	NA	7800	27400	MG/KG	2	
Arsenic (As)		2	2	5.6	9.8	7.7	NA	NA	0.43	21.6	MG/KG	2	
Barium (Ba)		2	2	20.6	24.2	22.4	NA	NA	550	54.2	MG/KG		
Beryllium (Be)		1	2	0.65	0.65	0.65	0.4	0.4	16	0.95	MG/KG		
Calcium (Ca)	N	2	2	23300	129000	76150	NA	NA	NA	NA	MG/KG		
Chromium (Cr)		2	2	25.4	31.1	28.3	NA	NA	39	34.5	MG/KG		
Cobalt (Co)		2	2	2.7	4	3.4	NA	NA	470	5.8	MG/KG		
Copper (Cu)		2	2	11.5	20.2	15.9	NA	NA	310	240	MG/KG		
Iron (Fe)	N	2	2	11400	13800	12600	NA	NA	NA	NA	MG/KG		
Lead (Pb)		2	2	17.3	25.2	21.3	NA	NA	400	203	MG/KG		
Magnesium (Mg)	N	2	2	2020	4810	3415	NA	NA	NA	NA	MG/KG		
Manganese (Mn)	*	2	2	195	588	392	NA	NA	160	419	MG/KG	2	1
Mercury (Hg)		2	2	0.07	0.08	0.075	NA	NA	2.3	0.47	MG/KG		
Nickel (Ni)		2	2	12.4	12.4	12.4	NA	NA	160	23.9	MG/KG		
Potassium (K)	N	2	2	853	1230	1042	NA	NA	NA	NA	MG/KG		
Sodium (Na)	N	2	2	196	468	332	NA	NA	NA	NA	MG/KG		
Vanadium (V)		2	2	27.0	29.8	28.4	NA	NA	55	113	MG/KG		
Zinc (Zn)		2	2	50	84.2	67.1	NA	NA	2300	206	MG/KG		
Pesticides/PCBs													
4,4'-DDD		2	2	1.8	2.7	2.3	NA	NA	2700	NA	µG/KG		
4,4'-DDE		2	2	6.7	23	14.9	NA	NA	1900	NA	µG/KG		
4,4'-DDT		2	2	2.1	5.2	3.7	NA	NA	1900	NA	µG/KG		
Heptachlor Epoxide		2	2	0.94	5.7	3.3	NA	NA	70	NA	µG/KG		
beta-BHC		1	2	0.32	0.32	0.32	4.3	4.3	350	NA	µG/KG		
gamma-BHC		1	2	0.34	0.34	0.34	2.2	2.2	490	NA	µG/KG		

Notes:
* - Indicates chemical was identified as a COPC
N - Indicates chemical is an essential nutrient
SQL - Sample quantitation limit
RBC - Risk-based concentration
µG/KG - micrograms per kilogram
MG/KG - milligrams per kilogram
NA - Not applicable or not available

Table 10.9.10
Chemicals Present in Site Samples
AOC 688 - Sediment
Charleston Naval Complex
Charleston, South Carolina

Parameter	Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration Residential RBC	Background	Units	Number Exceeding RBC	Background
Inorganics												
Aluminum (Al)	2	2	5240	6040	5640	NA	NA	7800	27400	MG/KG		
Antimony (Sb)	2	2	0.3	0.36	0.33	NA	NA	3.1	ND	MG/KG		
Arsenic (As)	2	2	2.9	3.8	3.4	NA	NA	0.43	21.6	MG/KG	2	
Barium (Ba)	2	2	13.3	14.1	13.7	NA	NA	550	54.2	MG/KG		
Calcium (Ca)	2	2	128000	167000	147500	NA	NA	NA	NA	MG/KG		
Chromium (Cr)	2	2	14.5	15.8	15.2	NA	NA	39	34.5	MG/KG		
Cobalt (Co)	2	2	1.5	2	1.8	NA	NA	470	5.8	MG/KG		
Copper (Cu)	2	2	8.3	10.7	9.5	NA	NA	310	240	MG/KG		
Iron (Fe)	2	2	4260	5400	4830	NA	NA	NA	NA	MG/KG		
Lead (Pb)	2	2	12.5	14.3	13.4	NA	NA	400	203	MG/KG		
Magnesium (Mg)	2	2	1850	2570	2210	NA	NA	NA	NA	MG/KG		
Manganese (Mn)	2	2	143	196	170	NA	NA	160	419	MG/KG	1	
Nickel (Ni)	2	2	5.4	8.3	6.9	NA	NA	160	23.9	MG/KG		
Potassium (K)	2	2	740	922	831	NA	NA	NA	NA	MG/KG		
Sodium (Na)	2	2	478	552	515	NA	NA	NA	NA	MG/KG		
Tin (Sn)	2	2	1.7	1.7	1.7	NA	NA	4700	7.5	MG/KG		
Zinc (Zn)	2	2	68.1	230	149	NA	NA	2300	206	MG/KG		1
Pesticides												
4,4'-DDD	2	2	0.82	1	0.91	NA	NA	2700	NA	µG/KG		
4,4'-DDE	2	2	13	35	24	NA	NA	1900	NA	µG/KG		
4,4'-DDT	2	2	1	3.4	2.2	NA	NA	1900	NA	µG/KG		
Aldrin	2	2	0.068	0.12	0.094	NA	NA	38	NA	µG/KG		
gamma-BHC	2	2	0.65	2	1.33	NA	NA	490	NA	µG/KG		
delta-BHC	2	2	0.77	0.92	0.85	NA	NA	350	NA	µG/KG		
Dieldrin	2	2	1.1	1.3	1.2	NA	NA	40	NA	µG/KG		
Endosulfan I	1	2	8.9	8.9	8.9	0.86	0.86	47000	NA	µG/KG		
Endosulfan II	2	2	4.7	6.8	5.75	NA	NA	47000	NA	µG/KG		
Endosulfan sulfate	1	2	0.47	0.47	0.47	1.3	1.3	47000	NA	µG/KG		
Endrin	1	2	1.4	1.4	1.4	1.6	1.6	2300	NA	µG/KG		
Endrin aldehyde	2	2	2.9	5	3.95	NA	NA	2300	NA	µG/KG		
Heptachlor	1	2	0.17	0.17	0.17	0.63	0.63	140	NA	µG/KG		
Heptachlor epoxide	2	2	0.56	0.59	0.575	NA	NA	70	NA	µG/KG		
Methoxychlor	1	2	4	4	4.00	1.6	1.6	39000	NA	µG/KG		
PCBs												
Aroclor-1260	1	2	98	98	98	11	11	320	NA	µG/KG		
Volatile Organics												
2-Butanone	1	2	2	2	2	40	40	4700000	NA	µG/KG		

Notes:
SQL - Sample quantitation limit
RBC - Risk-based concentration
µG/KG - micrograms per kilogram
MG/KG - milligrams per kilogram
NA - Not applicable or not available

Current site workers' exposure would be less than that assumed for the hypothetical future site worker scenario because of their limited surface soil and sediment contact. Therefore, future worker assessment is considered to be conservatively representative of current site workers. The resident child scenario was considered to be conservatively representative of the adolescent trespasser. The future site resident scenario was built on the premise that existing features would be removed and replaced with dwellings.

Exposure Pathways

Exposure pathways for both receptor groups are dermal contact and incidental ingestion of surface soil and sediment. The exposure pathways for future site residents are the same as those for the future site worker. In addition, the hypothetical future site worker scenario assumed continuous exposure to surface soil and sediment conditions. To provide a conservative account of potential exposure, standard soil exposure assumptions were applied to quantify sediment daily intake. Uniform exposure was assumed for all sample locations. Table 10.9.11 presents the justification for exposure pathways assessed in this HHRA.

Exposure Point Concentrations

As discussed in Section 7 of this RFI, UCLs are generally calculated for datasets consisting of at least 10 samples. The maximum concentration of manganese was used as the surface soil and sediment pathway EPC because fewer than 10 samples were collected.

Quantification of Exposure

Surface Soil/Sediment

CDIs for ingestion and dermal contact with sediments are shown in Tables 10.9.12 and 10.9.13, respectively.

Table 10.9.11
AOC 688
Exposure Pathways Summary

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Current Land Uses			
Current Users (Site Workers)	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	This exposure pathway was considered insignificant compared to the other pathways.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Shallow groundwater is not currently used as a source of potable or non-residential water at combined AOC 688.
	Shallow groundwater, Inhalation of volatilized shallow groundwater contaminants	No	Shallow groundwater is not currently used as a source of potable or non-residential water at combined AOC 688.
	Soil, Incidental ingestion	No (Qualified)	Future site use is considered conservatively representative of current site use.
	Soil, Dermal contact	No (Qualified)	Future site use is considered conservatively representative of current site use.
Future Land Uses			
Future Site Residents (Child and Adult), Future Site Worker	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	This exposure pathway was considered insignificant compared to the other pathways.
	Shallow groundwater, ingestion of contaminants during potable or general use	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Shallow groundwater, Inhalation of volatilized contaminants during domestic use	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Soil, Incidental ingestion	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.
	Soil, Dermal contact	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.
	Wild game or domestic animals, Ingestion of tissue impacted by media contamination	No	Hunting/taking of game and/or raising livestock is prohibited within the Charleston, South Carolina, city limits.
	Fruits and vegetables, Ingestion of plant tissues grown in media	No	The potential for significant exposure via this pathway is low relative to that of other exposure pathways assessed.

Table 10.9.12
Chronic Daily Intakes
Incidental Ingestion of Surface Soil and Sediment
AOC 688
Charleston Naval Complex
Charleston, South Carolina

Chemical	Fraction Ingested from Contaminated Source*	Exposure Point Concentration (mg/kg)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident LWA C-CDI (mg/kg-day)	Future Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Manganese (Mn)	1	588	8.05E-04	7.52E-03	9.21E-04	2.88E-04	1.03E-04

Notes:
LWA = Lifetime-weighted average; used to calculate carcinogenic CDI, *RAGS Parts A and B*.
CDI = Chronic Daily Intake in mg/kg-day
H-CDI = CDI for hazard quotient
C-CDI = CDI for excess cancer risk
* = Reflects the estimated fraction of the site impacted by the corresponding COPC.
mg/kg = Milligrams per kilogram
mg/kg-day = Milligrams per kilogram per day

Table 10.9.13
Chronic Daily Intakes
Dermal Contact with Surface Soil and Sediment
AOC 688
Charleston Naval Complex
Charleston, South Carolina

Chemical	Exposure Point Concentration (mg/kg)	Fraction Contacted from Contaminated Source *	Dermal Absorption Factor (unitless)+	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident lwa C-CDI (mg/kg-day)	Future Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Manganese (Mn)	588	1	0.001	3.30E-05	1.09E-04	2.07E-05	2.36E-05	8.42E-06

Notes:
CDI = Chronic daily intake in mg/kg-day
H-CDI = CDI for hazard quotient
C-CDI = CDI for excess cancer risk
+ = The dermal absorption factor was applied to the exposure point concentration to reflect the different transdermal migration of inorganic versus organic chemicals.
* = Reflects the estimated fraction of the site impacted by the corresponding COPC.
mg/kg-day = Milligrams per kilograms per day
mg/kg-day = Milligrams per kilograms

10.9.7.4 Toxicity Assessment

Toxicity assessment terms and methods are discussed in Section 7 of this report. Table 10.9.14 presents toxicological information specific to each COPC identified at AOC 688. This information was used in the quantification of risk/hazard associated with sediment. Brief toxicological profiles for each COPC are provided in the following paragraphs.

Manganese is an essential nutrient, but chronic exposure (0.8 mg/kg-day) causes mental disturbances. Studies have shown that manganese uptake from water is greater than manganese uptake from food, and the elderly appear to be more sensitive than children (Klaasen et al., 1986; Dreisbach et al., 1987). USEPA determined the RfD to be 0.14 mg/kg-day based on dietary uptake. USEPA recommended using a modifying factor of 3 when estimating intake from water. In addition, the body roughly absorbs twice as much manganese in water as it does manganese in food. Because of the different uptake rates in water and food, two RfDs were used in this HHRA - one for water and one for food. The RfDs used are 0.047 and 0.023 mg/kg-day, respectively. Inhalation of manganese dust causes neurological effects and increased incidence of pneumonia. An inhalation RfD was set to 1.43E-05 mg/kg-day. According to USEPA, manganese cannot be classified as to its carcinogenicity. Therefore, its cancer class is group D. As listed in IRIS, the classification is based on studies that are inadequate to assess the carcinogenicity of manganese. Manganese is considered essential to human health. The typical vitamin supplement dose of manganese is 2.5 mg/day. As listed in IRIS, this chemical's critical effects in water in the oral summary are CNS effects. The uncertainty factor was 1 and the recommended modifying factor of 3 was used to estimate soil and groundwater intake. The critical effects of this chemical are CNS effects. As listed in IRIS, the critical effect in the inhalation summary is impairment of neuro behavioral function. For inhalation uptake, the uncertainty factor was 1,000 and the modifying factor was 1. The IRIS RfC is 5E-05 mg/m^3.

Table 10.9.14
Toxicological Reference Information
for Chemicals of Potential Concern
AOC 688
Charleston Naval Complex
Charleston, South Carolina

	Non-Carcinogenic Toxicity Data								*Carcinogenic Toxicity Data*			
Chemical	**Oral Reference Dose (mg/kg-day)**	**Confidence Level**	**Critical Effect**	**Uncertainty Factor Oral**	**Inhalation Reference Dose (mg/kg-day)**	**Confidence Level**	**Critical Effect**	**Uncertainty Factor Inhalation**	**Oral Slope Factor (kg-day/mg)**	**Inhalation Slope Factor (kg-day/mg)**	**Weight of Evidence**	**Tumor Type**
Manganese (food)	0.14 a	M	neurological effects	1	1.43E-05 a	M	neurological effects	1000	NA	NA	D	NA

Notes:
a = Integrated Risk Information System (IRIS)
NA = Not applicable or not available
H = High confidence
L = Low confidence
M = Medium confidence

10.9.7.5 Risk Characterization

Surface Soil/Sediment Pathways

Exposure to sediment/surface soil onsite was evaluated under both residential and industrial (site worker) scenarios applying standard surface soil exposure assumptions. For these scenarios, the incidental ingestion and dermal contact exposure pathways were evaluated. For non-carcinogenic contaminants evaluated for future site residents, hazard was computed separately to address child and adult exposure. Tables 10.9.15 and 10.9.16 present the computed carcinogenic risks and/or HQs associated with the incidental ingestion of site surface soil and sediments, and dermal contact with it.

Hypothetical Site Residents

The computed hazard indices for the adult and child resident were 0.006 and 0.05 respectively for the soil ingestion pathway. The dermal contact pathway hazard indices were 0.001 and 0.004 for the adult resident and the child resident, respectively.

Future Site Workers

The hazard indices for both the ingestion and dermal contact pathways were less than 0.01.

The AOC 688 area is a reinforced earthen munitions bunker and associated driveway. Current site users have little chance of exposure to affected surface soil and sediment because their principal function is maintenance and operation of the bunker. As a result, the risk/hazard projections discussed above are considered gross overestimates should existing site features and functions be maintained under future use scenarios.

COCs Identified

No chemicals of concern were identified based on cumulative (all pathway) risk and hazard projected for this site. USEPA has established a generally acceptable risk range of 1E-04 to 1E-06, and a hazard index threshold of 1.0 (unity). As recommended by SCDHEC, a COC was

Table 10.9.15
Hazard Quotients and Incremental Lifetime Excess Cancer Risks
Incidental Surface Soil and Sediment Ingestion
AOC 688
Charleston Naval Complex
Charleston, South Carolina

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used $(mg/kg\text{-}day)^{-1}$	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident LWA ILCR	Future Worker adult Hazard Quotient	Future Worker adult ILCR
Manganese (Mn)	0.14	NA	0.0058	0.054	ND	0.0021	ND
SUM Hazard Index/ILCR			0.006	0.05	ND	0.002	ND

Notes:
NA = Not available
ND = Not determined due to lack of available information
LWA = Lifetime-weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A.
ILCR = Incremental Lifetime excess Cancer Risk
mg/kg-day = Milligrams per kilgram per day

Table 10.9.16
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil and Sediment
AOC 688
Charleston Naval Complex
Charleston, South Carolina

Chemical	Dermal Adjustment*	Oral RfD Used (mg/kg-day)	Oral SF Used $(mg/kg\text{-}day)^{-1}$	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident LWA ILCR	Future Worker adult Hazard Quotient	Future Worker adult ILCR
Manganese (Mn)	0.2	0.028	NA	0.0012	0.0039	ND	0.0008	ND
SUM Hazard Index/ILCR				0.001	0.004	ND	0.0008	ND

Notes:
NA = Not available
ND = Not determined due to lack of available information
LWA = Lifetime-weighted average; used to calculate excess carcinogenic risk derived from *RAGS Part A*.
ILCR = Incremental lifetime cancer risk
* = Dermal to absorbed dose adjustment factor is applied to adjust for oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency, which should not be applied to dermal exposure and dermal CDI).
mg/kg-day = Milligrams per kilograms per day

considered to be any chemical contributing to a cumulative risk level of 1E-06 or greater and/or a cumulative hazard index above 1.0, if its individual ILCR exceeds 1E-06 or its hazard quotient exceeds 0.1. For carcinogens, this approach is relatively conservative, because a cumulative risk level of 1E-04 (and individual ILCR of 1E-06) is recommended by USEPA Region IV as the trigger for establishing COCs. The COC selection method was used to more comprehensively evaluate chemicals contributing to carcinogenic risk or non-carcinogenic hazard during remedial goal option development. Table 10.9.17 summarizes the COCs identified on a medium specific basis.

Surface Soil/Sediment

Hypothetical Site Residents (Future Land Use)

No COCs were identified for this scenario based on the sum ILCR and hazard index.

Future Site Workers (Current Land Use)

No COCs were identified for this scenario based on the sum ILCR and hazard index.

10.9.7.6 Risk Uncertainty

Characterization of Exposure Setting and Identification of Exposure Pathways

The potential for high bias is introduced through the exposure setting and pathway selection due to the highly conservative assumptions (i.e., future residential use) recommended by USEPA Region IV when assessing potential future and current exposure. The exposure assumptions made in the site worker scenario are highly conservative and would tend to overestimate exposure. Current site workers are infrequently exposed to surface soil/sediment onsite. Current site workers are not exposed to site groundwater.

Table 10.9.17
Summary of Risk and Hazard-based COCs
AOC 688
Charleston Naval Complex
Charleston, South Carolina

Medium	Exposure Pathway		Future Resident Adult Hazard Quotient	Future Resident Child Hazard Quotient	Future Resident LWA ILCR	Current Site Worker Hazard Quotient	Current Site Worker ILCR	Identification of COCs
Surface Soil/Sediment	Incidental Ingestion	Manganese (Mn)	0.006	0.05	ND	0.002	ND	NA
	Dermal Contact	Manganese (food)	0.0012	0.0039	ND	0.0008	ND	NA
Surface Soil/Sediment Pathway Sum			0.007	0.05	ND	0.003	ND	
Sum of All Pathways			0.007	0.05	ND	0.003	ND	

Notes:
ND = not determined due to the lack of available risk information.
ILCR = incremental excess lifetime cancer risk.
HI = hazard index
NA = Not applicable
LWA = Lifetime-weighted average; used to calculate excess carcenogenic risk derived from *RAGS Part A*.

Residential use of the site would not be expected, based on current site uses and the surrounding buildings. Current reuse plans call for continued commercial/industrial use of Zone I, specifically as a marine cargo terminal. If this area were to be used as a residential site, the munitions bunker would be demolished, asphalt surface removed, and surface soil and sediment conditions would likely change. The soils could be covered with landscaping soil, and/or houses. Consequently, exposure to current surface soil and sediment conditions would not be likely under a true future residential scenario. These factors indicate that exposure pathways assessed in this HHRA would generally overestimate the risk and hazard posed to current site workers and future site residents.

Determination of Exposure Point Concentrations

No surface soil or sediment COPC UCLs were calculated because fewer than 10 samples were collected. The maximum concentration of manganese was applied as the EPC and modified in accordance with the "hot spot" approach.

Frequency of Detection and Spatial Distribution

Manganese was detected in the two sediment samples and the two soil samples collected. The maximum manganese surface soil concentration (588 mg/kg) was detected at 688SB002; it exceeded its RBC and background concentration. The maximum manganese sediment concentration (196 mg/kg) was detected at 688M0002; it exceeded its RBC, but was below its background concentration.

Quantification of Risk/Hazard

As indicated by the discussions above, the uncertainty inherent in the risk assessment process is great. In addition, many site-specific factors have affected the uncertainty of this assessment that would upwardly bias the risk and hazard estimates. Exposure pathway-specific sources of uncertainty are discussed below.

Surface Soil/Sediment

Of the CPSSs screened from formal assessment, none eliminated was reported at concentrations within approximately 10% of the RBC. This minimizes the likelihood of potentially significant cumulative risk/hazard with respect to the eliminated CPSSs. Aluminum and arsenic exceeded their corresponding RBCs, but these elements did not exceed the corresponding soil background concentrations. Therefore, they were eliminated from formal assessment based on comparisons to corresponding background concentrations.

Although AOC 688 future land use is unknown, both the worker and residential exposure scenarios were assessed in this HHRA. Current base reuse plans call for conversion of the area to a marine cargo terminal. As previously discussed, it is likely that these scenarios would lead to overestimates of risk and/or hazard.

Background-Related Risk

Surface Soil/Sediment

Aluminum and arsenic were detected in AOC 688 surface soil or sediment at concentrations above their respective RBCs. They were eliminated from consideration in the risk assessment based on comparison to corresponding background values. It is not unusual for naturally occurring or background concentrations of some elements to exceed risk-based concentrations. It is the risk assessment's function to identify excess risk and/or hazard, or that which exceeds background levels. The following discusses residential scenario risk/hazard associated with background concentrations of aluminum and arsenic.

Aluminum's maximum surface soil concentration (12,600 mg/kg) for AOC 688 equates with hazard quotients of 0.2 and 0.01 for the residential child and site worker, respectively. Its background value (27,400 mg/kg) results in hazard quotients of 0.4 and 0.02 for the residential child and site worker, respectively. Arsenic's maximum surface soil concentration (9.8 mg/kg) equates with ILCRs of 3E-05 and 4E-06 for the residential and site workers scenarios, respectively. Its maximum reported concentration equates with hazard quotients of 0.4 and 0.02 for the residential child and site worker, respectively. Arsenic's background value (21.6 mg/kg) equates with ILCRs of 6E-05 and 8E-06, and hazard quotients of 1 and 0.05 for the residential and site worker scenarios, respectively.

10.9.7.7 Risk Summary

The risk and hazard posed by contaminants at AOC 688 were assessed for the hypothetical site worker and the hypothetical future site resident under reasonable maximum exposure assumptions. For surface soil and sediment, the incidental ingestion and dermal contact pathways were assessed in this HHRA. Table 10.9.18 presents the risk summary for each pathway/receptor group evaluated for AOC 688.

Soil — Residential Scenario

No residential surface soil or sediment pathway COCs were identified for AOC 688.

Soil — Site Worker Scenario

No site worker surface soil or sediment pathway COCs were identified for AOC 688.

10.9.7.8 Remedial Goal Options

Surface Soil/Sediment

No RGOs were calculated for site surface soil or sediment because no COCs were identified.

10.9.8 Corrective Measures Considerations

Based on the analytical results and the human health risk assessment for AOC 688, no COCs have been identified. Risk to human health from COPCs was evaluated under both the residential and industrial (site worker) scenarios for incidental ingestion and dermal contact. Hazard was

Table 10.9.18
Summary of Risk and Hazard
AOC 688
Charleston Naval Complex
Charleston, South Carolina

Medium	Exposure Pathway	HI (Adult)	HI (Child)	ILCR (LWA)	HI (Worker)	ILCR (Worker)
Surface Soil and Sediment	Incidental Ingestion	ERR	ERR	ND	ERR	ND
	Dermal Contact	ERR	ERR	ND	ERR	ND
Sum of All Pathways		ERR	ERR	ND	ERR	ND

Notes:
ND = indicates not determined due to the lack of available risk information.
ILCR = indicates incremental excess lifetime cancer risk.
HI = indicates hazard index
LWA = Lifetime-weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A

evaluated for noncarcinogenic contaminants through incidental ingestion and dermal contact scenarios as well.

As recommended by SCDHEC, a COC is considered to be any chemical contributing to a cumulative risk level of at least 1E-06 and/or a cumulative hazard index above 1.0. Based on these criteria, no chemical was identified as a soil pathway COC for AOC 688. Therefore, no further action is required based on the analytical results and risk assessment.

10.10 AOC 689, Southern Tip of Base (Marina Parking Area) and AOC 690, Dredged Materials Area Roads

AOC 689 is the unpaved marina parking area and surrounding marshlands at the southern tip of the base. The parking lot is currently in use. This site is bounded to the east by Cooper River, to the north by the Dredged Materials Area, and to the south and west by Shipyard Creek. The marina parking area has reportedly been used for unauthorized disposal of unknown materials during filling activities.

AOC 690 is the network of roads at the southern tip of the base and along Shipyard Creek, including the Lunsford Loop, a portion of Juneau Avenue, and West Road. This site extends along West Road on the boundary between Zones I and H and the Dredged Materials Area. The areas along these gravel roads, totaling approximately 4,500 feet, are reported locations of unauthorized hazardous materials dumping by Navy personnel.

Although the history of hazardous materials dumping is largely unknown, petroleum products are suspected materials of concern. Potential receptor, include current parking lot users and current or future site workers who perform invasive or noninvasive activities which might bring them into direct contact with contaminants. Cooper River, Shipyard Creek, and their associated wetlands are also potential ecological receptors of point and nonpoint source discharges.

To fulfill CSI objectives, soil and groundwater were sampled in accordance with the approved final RFI work plan and Section 3 of this report. In this section, contiguous AOCs 689 and 690 may be together referred to as "the combined AOCs."

10.10.1 Soil Sampling and Analysis

Soil was sampled in four rounds at AOCs 689 and 690 at the locations shown on Figure 10.10.1. The final RFI work plan proposed 20 soil samples each from the upper- and lower- soil intervals.

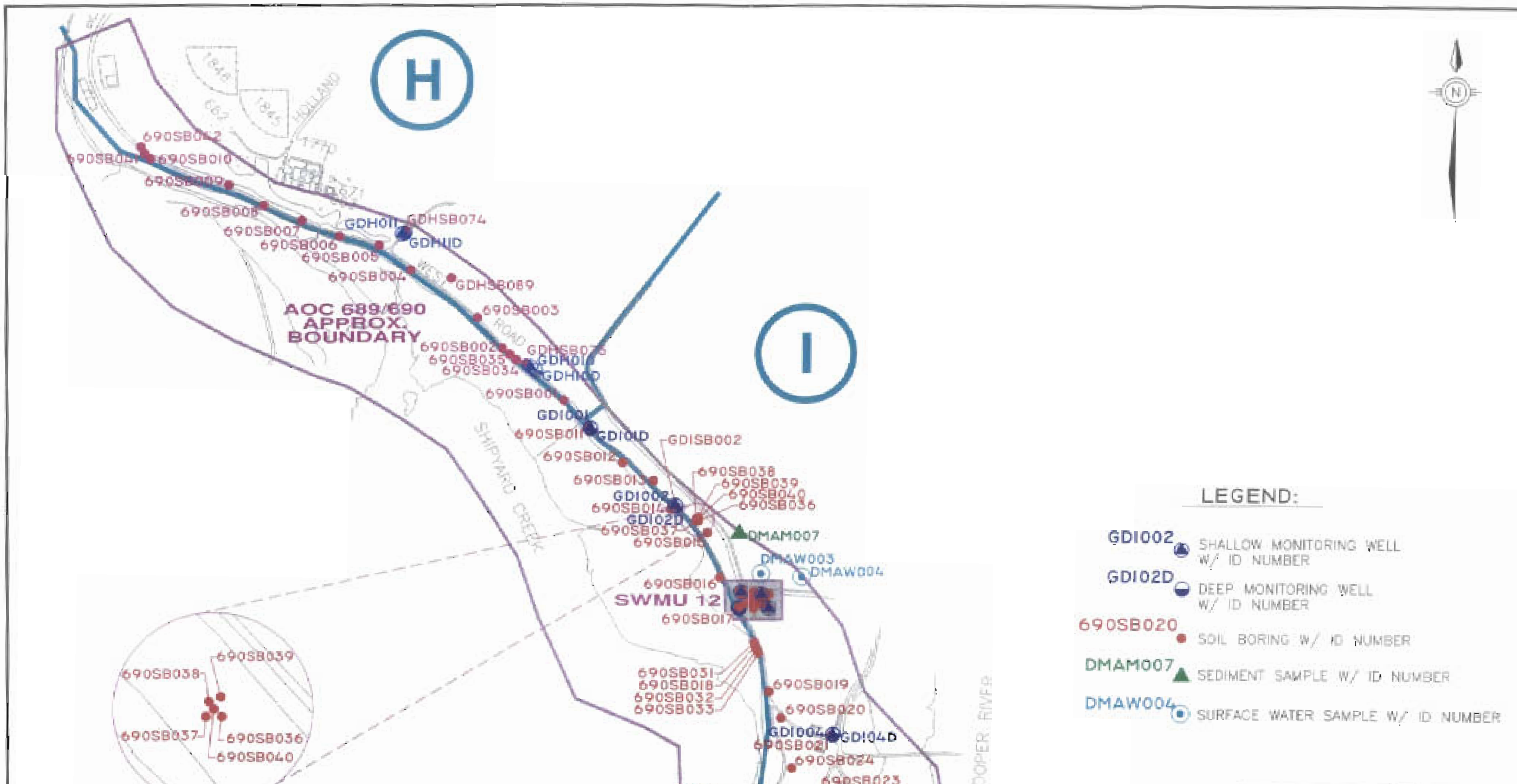
Ten of the 20 proposed upper-interval samples were collected in the first-round and analyzed for the standard suite (VOCs, SVOCs, metals, cyanide, pesticides, and PCBs) and TPH at DQO Level III. Additionally, one surface soil sample was collected from grid boring GDISB002 during the first-round.

In the second-round, 20 upper-interval samples and seven of the 20 proposed lower-interval samples were collected. The 10 additional surface samples were included to help delineate the extent of contamination, if any, in the marina parking area. The remaining 13 lower-interval samples were not collected because the water table was encountered at less than 5 feet bgs. Second-round samples were submitted for the standard suite plus organotins and dioxins at DQO Level III. One duplicate was submitted in round one for Appendix IX and TPH analyses at DQO Level IV, and two were submitted in round two for Appendix IX analysis at DQO Level IV.

Third-round sampling was performed following a comparison of first and second-round analytical results to RBCs and SSLs. This comparison showed that surface soil sample 690SB01801 contained SVOCs above the RBCs; therefore, three additional upper-interval samples were collected in the vicinity of 690SB018 for SVOC analysis (690SB031, 690SB032, and 690SB033). Fourth-round samples were collected in the vicinity of 690SB002 and 690SB010 to help confirm and delineate potential dumping areas. Five fourth-round samples were also collected in the vicinity of the area where buried drums were discovered and removed (borings 690SB036 through 690SB040). Fourth-round samples were analyzed for VOCs, SVOCs, and metals at DQO Level III. Table 10.10.1 summarizes the four rounds of sampling.

10.10.2 Nature and Extent of Contamination in Soil

Organic compound analytical results for soil are summarized in Table 10.10.2. Inorganic analytical results are summarized in Table 10.10.3. Table 10.10.4 summarizes analytes detected in surface and subsurface soils at AOCs 689/690. Appendix D contains a complete analytical data report for all samples collected in Zone I, including AOCs 689 and 690.



ZONE I
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.10.1
AOC 689 / 690
SAMPLING LOCATIONS

Date: 02/17/99 | DWG Name: 2909C034

Table 10.10.1
AOC 689/690
Soil Sampling Summary

Sampling Round	Sampling Date	Samples Collected	Sample Analyses	Comments
1	12/14/94 12/16/94	Upper - 10 (20)	Standard suite, TPH	No lower interval sampling was planned.
		Duplicate - 1	Appendix IX, TPH	
2	02/08/95 02/09/95 02/13/95 02/14/95 02/16/95	Upper - 20	Standard Suite, Organotins, Dioxins, Additional Parameters[a]	Additional samples were collected. Additional parameters were added.
	03/07/95 03/08/95 03/09/95	Lower -7 (20)	Standard Suite, Organotins, Dioxins	Some lower samples were not collected due to a water table at less than 5 feet bgs.
		Duplicate - 2	Appendix IX	
3	06/20/95	Upper - 3	SVOCs	Samples were collected to delineate the extent of SVOCs detected above their RBCs.
4	04/02/98 04/06/98	Upper - 9	VOCs, SVOCs, Metals	
		Lower - 7	VOCs, SVOCs, Metals	
		Duplicate - 1	VOCs, SVOCs, Metals	

Notes:

( ) = Parenthesis indicate number of samples proposed

a = Additional analysis performed on two samples on 09/06/95 included CEC, chloride, sulfur, ammonia, nitrate/nitrite, phosphorus, TOC, and total moisture. These two samples were also extracted using the TPLP and the extract was analyzed for VOAs and SVOAs.

Standard Suite = VOCs, SVOCs, metals, cyanide, pesticides, and PCBs at DQO Level III.

Appendix IX = Standard Suite, plus hex-chrome, dioxins, herbicides, and OP pesticides at DQO Level IV.

Table 10.10.2
AOC 689/690 Soil
Organic Compound Analytical Results for Soil (μg/kg)

Parameters	Sample Interval	Detection Frequency	Detection Range	Mean	RBC (upper) SSL (lower)	Number of Samples Exceeding RBC or SSL
Volatile Organic Compounds						
1,1-Dichloroethene	Upper	1/39	2.3	2.3	1,100	0
	Lower	0/14	ND	ND	30	0
Acetone	Upper	7/39	38.0 - 1,500	378	780,000	0
	Lower	3/14	46 - 69.0	60.0	8,000	0
Benzene	Upper	1/39	2.9	2.9	22,000	0
	Lower	0/14	ND	ND	15	0
2-Butanone	Upper	0/39	ND	ND	4,700,000	0
	Lower	1/14	12.0	12.0	3,900	0
Carbon disulfide	Upper	1/39	4.4	4.4	780,000	0
	Lower	2/14	3.0 - 12.0	7.5	16,000	0
Chloromethane	Upper	2/39	24.7 - 60.0	42.4	49,000	0
	Lower	0/14	ND	ND	3.7	0
Ethylbenzene	Upper	1/39	2.2	2.2	780,000	0
	Lower	1/14	2.3	2.3	6,500	0
Methylene chloride	Upper	5/39	2.0 - 67.0	29.4	85,000	0
	Lower	1/14	2.7	2.7	10	0
Propionitrile (Ethyl cyanide)	Upper	1/39	660	660	47,000	0
	Lower	0/14	ND	ND	440	0
Tetrachloroethene	Upper	1/39	4.4	4.4	12,000	0
	Lower	0/14	ND	ND	30	0
Toluene	Upper	10/39	2.0 - 12.9	4.9	1,600,000	0
	Lower	3/14	1.5 - 8.0	3.8	6,000	0
Trichloroethene	Upper	4/39	3.7 - 14.0	7.7	58,000	0
	Lower	0/14	ND	ND	30	0
Trichlorofluoromethane	Upper	1/39	3.4	3.4	2,300,000	0
	Lower	0/14	ND	ND	10,000	0
Xylene (Total)	Upper	1/39	2.5	2.5	16,000,000	0
	Lower	2/14	2.9 - 9.3	6.1	70,000	0
Semivolatile Organic Compounds						
BEQs	Upper	17/42	0.39 - 1788	278	87	7
	Lower	2/14	17.8 - 140	78.9	1,600	0
Benzo(a)anthracene	Upper	9/42	46.0 - 1,500	428	870	1
	Lower	2/14	66.0 - 110	88.0	800	0

Table 10.10.2
AOC 689/690 Soil
Organic Compound Analytical Results for Soil (μg/kg)

Parameters	Sample Interval	Detection Frequency	Detection Range	Mean	RBC (upper) SSL (lower)	Number of Samples Exceeding RBC or SSL
Benzo(a)pyrene	Upper	11/42	47.0 - 1,200	296	87	6
	Lower	1/14	110	110	4,000	0
Benzo(b)fluoranthene	Upper	16/42	41.2 - 2,400	416	870	2
	Lower	2/14	100 - 170	135	2,500	0
Benzo(k)fluoranthene	Upper	15/42	39.0 - 2,600	430	8,700	0
	Lower	2/14	110 - 190	150	25,000	0
Chrysene	Upper	13/42	46.0 - 1,600	363	87,000	0
	Lower	2/14	88.0 - 100	94.0	80,000	0
Dibenzo(a,h)anthracene	Upper	3/42	28.0 - 130	92.7	87	2
	Lower	0/14	ND	ND	800	0
Indeno(1,2,3-cd) pyrene	Upper	3/42	90.0 - 410	253	870	0
	Lower	0/14	ND	ND	7,000	0
1-Methylnaphthalene	Upper	7/23	47.0 - 760	216	310,000	0
	Lower	0/7	ND	ND	72,000	0
2-Methylnaphthalene	Upper	7/42	39.0 - 690	221	310,000	0
	Lower	0/14	ND	ND	230,000	0
4-Aminobiphenyl	Upper	1/24	60.0	60.0	2.8	1
	Lower	0/7	ND	ND	NA	0
Acenaphthene	Upper	1/42	210	210	470,000	0
	Lower	0/14	ND	ND	290,000	0
Acetophenone	Upper	1/24	51.0	51.0	780,000	0
	Lower	0/7	ND	ND	0.12	0
Anthracene	Upper	4/42	17.0 - 340	130	2,300,000	0
	Lower	0/14	ND	ND	5,900,000	0
Benzo(g,h,i)perylene	Upper	3/42	85.0 - 430	252	310,000	0
	Lower	0/14	ND	ND	1.2E+08	0
Benzoic Acid	Upper	1/42	25,000	25,000	31,000,000	0
	Lower	0/14	ND	ND	200,000	0
Benzyl Alcohol	Upper	1/42	370	370	2,300,000	0
	Lower	0/14	ND	ND	25,000	0
Butylbenzylphthalate	Upper	1/42	97.0	97.0	1,600,000	0
	Lower	0/14	ND	ND	930,000	0
Chlorobenzilate	Upper	1/24	45.8	45.8	2,400	0
	Lower	0/7	ND	ND	100	0
Di-n-butylphthalate	Upper	13/42	41.0 - 120	61.9	780,000	0
	Lower	5/14	46.0 - 140	90.2	2,300,000	0

Table 10.10.2
AOC 689/690 Soil
Organic Compound Analytical Results for Soil (μg/kg)

Parameters	Sample Interval	Detection Frequency	Detection Range	Mean	RBC (upper) SSL (lower)	Number of Samples Exceeding RBC or SSL
Dibenzofuran	Upper	5/42	20.0 - 170	80.6	31,000	0
	Lower	0/14	ND	ND	6,800	0
Fluoranthene	Upper	18/42	18.0 - 2,600	427	310,000	0
	Lower	3/14	22.0 - 87.0	61	2,100,000	0
Fluorene	Upper	1/42	160	160	310,000	0
	Lower	0/14	ND	ND	280,000	0
Naphthalene	Upper	5/42	72.0 - 540	214	310,000	0
	Lower	0/14	ND	ND	42,000	0
Phenanthrene	Upper	11/42	12.0 - 1,300	364	230,000	0
	Lower	0/14	ND	ND	660,000	0
Pyrene	Upper	17/42	15.0 - 2,200	371	230,000	0
	Lower	3/14	18.0 - 100	62	2,100,000	0
bis (2-Ethylhexyl) phthalate	Upper	11/42	44.0 - 1,300	337	46,000	0
	Lower	1/14	110	110	1,800,000	0
TPHs						
TPH	Upper	2/10	140 - 820	480	NA	0
	Lower	0/0	NA	NA	NA	0
Pesticides/PCBs						
4,4'-DDD	Upper	3/30	3.7 - 26.0	14.6	2,700	0
	Lower	0/7	ND	ND	8,000	0
4,4'-DDE	Upper	9/30	2.4 - 60.0	16.8	1,900	0
	Lower	0/7	ND	ND	27,000	0
Aldrin	Upper	2/30	1.9 - 2.7	2.3	38	0
	Lower	0/7	ND	ND	230	0
Chlordane	Upper	1/20	7.6	7.6	1,800	0
	Lower	0/7	ND	ND	5,000	0
Dieldrin	Upper	1/30	11.1	11.1	40	0
	Lower	0/7	ND	ND	2	0
Endosulfan I	Upper	4/30	2.0 - 33.0	10.4	47,000	0
	Lower	0/7	ND	ND	9,000	0
Endosulfan II	Upper	2/30	6.1 - 7.0	6.55	47,000	0
	Lower	1/7	4.5	4.5	9,000	0
Endrin	Upper	1/30	5.6	5.6	2,300	0
	Lower	0/7	ND	ND	500	0

Table 10.10.2
AOC 689/690 Soil
Organic Compound Analytical Results for Soil (μg/kg)

Parameters	Sample Interval	Detection Frequency	Detection Range	Mean	RBC (upper) SSL (lower)	Number of Samples Exceeding RBC or SSL
Endrin aldehyde	Upper	2/30	1.2 - 1.9	1.55	2,300	0
	Lower	0/7	ND	ND	340	0
Heptachlor	Upper	3/30	1.2 - 3.1	2.13	140	0
	Lower	0/7	ND	ND	11,000	0
Heptachlor epoxide	Upper	2/30	1.4 - 1.5	1.45	70	0
	Lower	0/7	ND	ND	330	0
Methoxychlor	Upper	3/30	2.80 - 75.0	28.1	39,000	0
	Lower	0/7	ND	ND	80,000	0
Methyl parathion	Upper	1/3	28.0	28.0	2,000	0
	Lower	0/0	NA	NA	150	0
alpha-Chlordane	Upper	1/10	2.3	2.3	1,800	0
	Lower	0/0	NA	NA	5,000	0
beta-BHC	Upper	3/30	1.5 - 2.7	2.0	350	0
	Lower	1/7	1.9	1.9	1.3	1
delta-BHC	Upper	2/30	2.3 - 7.4	4.85	350	0
	Lower	0/7	ND	ND	1.8	0
gamma-Chlordane	Upper	1/10	4.0	4.0	1,800	0
	Lower	0/0	NA	NA	5,000	0
gamma-BHC (Lindane)	Upper	2/30	1.2 - 3.7	2.45	490	0
	Lower	0/7	ND	ND	4.5	0
Aroclor-1260	Upper	6/30	39.0 - 170	90.7	320	0
	Lower	1/7	73.0	73.0	1,000	0
Herbicides						
2,4,5-T	Upper	2/2	6.3 - 13.0	9.65	78,000	0
	Lower	0/0	NA	NA	990	0
Dioxin Compounds						
TEQs	Upper	21/23	4.4E-05 - 3.9E-03	6.97E-4	4.30E-03	0
	Lower	6/6	1.3E-05 - 3.49E-04	1.47E-4	1.6	0
123789-HxCDD	Upper	2/23	1.09E-03 - 2.56E-03	1.82E-03	0.043	0
	Lower	0/6	ND	ND	4.1	0
1234678-HpCDD	Upper	21/23	8.07E-04 - 0.0716	0.0190	0.430	0
	Lower	6/6	6.52E-04 - 0.0145	4.11E-03	108	0
OCDD	Upper	21/23	0.036 - 0.831	0.22	4.30	0
	Lower	6/6	6.82E-03 - 0.203	0.077	1,080	0

Table 10.10.2
AOC 689/690 Soil
Organic Compound Analytical Results for Soil (μg/kg)

Parameters	Sample Interval	Detection Frequency	Detection Range	Mean	RBC (upper) SSL (lower)	Number of Samples Exceeding RBC or SSL
123478-HxCDF	Upper	7/23	4.51E-04 - 2.95E-03	1.72E-03	0.043	0
	Lower	1/6	7.48E-04	7.48E-04	216	0
123678-HxCDF	Upper	10/23	6.52E-04 - 3.01E-03	1.35E-03	0.043	0
	Lower	0/6	ND	ND	216	0
123789-HxCDF	Upper	1/23	6.56E-04	6.56E-04	0.043	0
	Lower	1/6	3.38E-04	3.38E-04	216	0
234678-HxCDF	Upper	1/23	1.19E-03	1.19E-03	0.043	0
	Lower	0/6	ND	ND	216	0
1234678-HpCDF	Upper	20/23	4.55E-04 - 0.0167	3.77E-03	0.430	0
	Lower	3/6	3.22E-04 - 5.06E-03	1.91E-03	54	0
OCDF	Upper	19/23	4.73E-04 - 2.63E-02	7.09E-03	4.30	0
	Lower	2/6	1.43E-03 - 8.68E-03	5.05E-03	540	0
123478-HxCDD	Upper	1/23	1.52E-03	1.52E-03	0.043	0
	Lower	0/6	ND	ND	4.1	0
123678-HxCDD	Upper	2/23	1.99E-04 - 2.57E-03	2.28E-03	0.043	0
	Lower	0/6	ND	ND	4.1	0
12378-PeCDF	Upper	1/23	2.32E-03	2.32E-03	0.085	0
	Lower	0/6	ND	ND	0.8	0
23478-PeCDF	Upper	1/23	1.34E-03	1.34E-03	8.5E-03	0
	Lower	0/6	ND	ND	0.1	0
2378-TCDF	Upper	2/23	2.27E-03 - 3.55E-03	2.91E-03	0.043	0
	Lower	0/6	ND	ND	0.2	0
Organotins						
Dibutyltin	Upper	1/20	6.66	6.66	2,300	0
	Lower	1/5	6.65	6.65	NA	0
Monobutylin	Upper	0/20	ND	ND	2,300	0
	Lower	1/5	8.16	8.16	NA	0
Tributyltin	Upper	0/20	ND	ND	2,300	0
	Lower	1/5	7.64	7.64	NA	0

Notes:
NA = Not Applicable/Not Available/Not Analyzed
ND = Not Detected/Not Determined
μg/kg = micrograms per kilogram
See Table 5.5 for organic compound screening concentrations and their sources.

Table 10.10.3
AOC 689/690
Inorganic Compound Analytical Results for Soil (mg/kg)

Parameter	Sample Interval	Detection Frequency	Detection Range	Mean	Background	RBC (upper) SSL (lower)	Number of Samples Exceeding RBC and Background (upper) or SSL and Background (lower)
Aluminum (Al)	Upper	39/39	920 - 22,400	7,550	27,400	7,800	0
	Lower	14/14	6,370 - 22,500	12,600	189,000	560,000	0
Antimony (Sb)	Upper	4/39	0.28 - 24.5	6.45	ND	3.1	1
	Lower	0/14	ND	ND	ND	2.7	0
Arsenic (As)	Upper	37/39	1.3 - 28.7	7.0	21.6	0.43	2
	Lower	14/14	4.2 - 13.0	8.4	6.45	15	0
Barium (Ba)	Upper	30/39	5.6 - 203	28.2	54.2	550	0
	Lower	14/14	10.4 - 33.6	21.1	36	820	0
Beryllium (Be)	Upper	8/39	0.39 - 1.0	0.63	0.95	16	0
	Lower	11/14	0.35 - 1.8	0.70	0.67	32	0
Cadmium (Cd)	Upper	11/39	0.07 - 1.0	0.58	0.61	7.8	0
	Lower	6/14	0.22 - 0.61	0.48	0.54	4	0
Calcium (Ca)	Upper	39/39	4,870 - 337,000	93,000	NL	NL	NA
	Lower	14/14	19,600 - 177,000	54,800	NL	NL	NA
Chromium (Cr) (Total)	Upper	39/39	4.1 - 132	33.2	34.5	39	11
	Lower	14/14	21.5 - 51.7	34.1	51.3	19	1
Chromium (Cr) (Hexavalent)	Upper	2/3	0.512 - 3.98	2.25	ND	39	0
	Lower	0/0	NA	NA	ND	19	0
Cobalt (Co)	Upper	25/39	0.32 - 4.6	2.7	5.8	470	0
	Lower	14/14	0.99 - 5.5	3.0	3.48	990	0
Copper (Cu)	Upper	35/39	0.72 - 321	47.8	240	310	1
	Lower	14/14	7.7 - 30.2	14.4	11.5	5,600	0

Table 10.10.3
AOC 689/690
Inorganic Compound Analytical Results for Soil (mg/kg)

Parameter	Sample Interval	Detection Frequency	Detection Range	Mean	Background	RBC (upper) SSL (lower)	Number of Samples Exceeding RBC and Background (upper) or SSL and Background (lower)
Iron (Fe)	Upper	39/39	775 - 22,700	7,780	NL	NL	NA
	Lower	14/14	3,680 - 27,000	12,800	NL	NL	NA
Lead (Pb)	Upper	38/39	2.8 - 173	38.1	203	400	0
	Lower	14/14	2.5 - 43.3	13.0	12.3	400	0
Magnesium (Mg)	Upper	39/39	144 - 5,680	2,760	NL	NL	NA
	Lower	14/14	2,020 - 10,600	4,110	NL	NL	NA
Manganese (Mn)	Upper	39/39	8.7 - 461	129	419	160	1
	Lower	14/14	60.8 - 400	175	118	480	0
Mercury (Hg)	Upper	25/39	0.02 - 0.67	0.16	0.47	2.3	0
	Lower	11/14	0.02 - 0.20	0.11	ND	1	0
Nickel (Ni)	Upper	35/39	0.56 - 62.3	14.0	23.9	160	0
	Lower	14/14	6.7 - 28.0	12.5	15.7	65	0
Potassium (K)	Upper	35/39	167 - 2,340	1,010	NL	NL	NA
	Lower	14/14	917 - 2,200	1,540	NL	NL	NA
Selenium (Se)	Upper	29/39	0.11 - 1.60	0.75	1.49	39	0
	Lower	11/14	0.67 - 1.40	1.06	1.77	2.6	0
Sodium (Na)	Upper	22/39	30.2 - 2,300	620	NL	NL	NA
	Lower	13/14	412 - 2,050	1,220	NL	NL	NA
Tin (Sn)	Upper	10/39	0.96 - 14.6	5.92	7.5	4,700	0
	Lower	2/14	1.2 - 1.3	1.25	ND	5,500	0
Vanadium (V)	Upper	36/39	3.4 - 47.7	20.2	113	55	0
	Lower	14/14	19.7 - 53.3	31.4	38.1	3,000	0

Table 10.10.3
AOC 689/690
Inorganic Compound Analytical Results for Soil (mg/kg)

Parameter	Sample Interval	Detection Frequency	Detection Range	Mean	Background	RBC (upper) SSL (lower)	Number of Samples Exceeding RBC and Background (upper) or SSL and Background (lower)
Zinc (Zn)	Upper	37/39	2.6 - 319	72.6	206	2,300	0
	Lower	14/14	25.3 - 78.2	42.1	36.2	6,200	0

Notes:
NL = Not Listed
NA = Not Applicable/Not Available/Not Analyzed
ND = Not Detected/Not Determined
mg/kg = milligrams per kilogram
See Table 5.6 for inorganic screening concentrations and their sources.

Table 10.10.4
AOC 689/690
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Volatile Organic Compounds (μg/kg)							
Acetone	690SB003	44	780000	NA	NT	8000	NA
	690SB005	870			NT		
	690SB006	60			NT		
	690SB010	1500			NT		
	690SB015	38			ND		
	690SB026	38			NT		
	690SB029	ND			66		
	690SB030	96			NT		
	690SB034	ND			69		
	690SB035	ND			46		
Benzene	690SB002	2.9	22000	NA		15	NA
2-Butanone (MEK)	690SB034	ND	4700000	NA	12	3900	NA
Carbon disulfide	690SB002	4.4	780000	NA	NT	16000	NA
	690SB034	ND			12		
	690SB035	ND			3		
Chloromethane	690SB002	24.7	49000	NA	NT	3.7	NA
	690SB005	60			NT		
1,1-Dichloroethene	690SB002	2.3	1100	NA	NT	30	NA

Table 10.10.4
AOC 689/690
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Ethylbenzene	690SB034	2.2	780000	NA	ND	6500	NA
	690SB035	ND			2.3		
Methylene chloride	690SB003	14	85000	NA	NT	10	NA
	690SB005	67			NT		
	690SB010	62			NT		
	690SB036	ND			2.7		
	690SB037	2.2			ND		
	690SB038	2			ND		
Propionitrile (ethyl cyanide)	690SB016	660	47000	NA	NT	440	NA
Tetrachloroethene (PCE)	690SB002	4.4	12000	NA	NT	30	NA
Toluene	690SB001	3.6	1600000	NA	NT	6000	NA
	690SB002	12.85			NT		
	690SB004	7			NT		
	690SB006	3.7			NT		
	690SB010	10			NT		
	690SB017	2			NT		
	690SB023	2			ND		
	690SB024	2			NT		
	690SB028	2			ND		

Table 10.10.4
AOC 689/690
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Toluene (Continued)	690SB029	ND			8		
	690SB030	4			NT		
	690SB034	ND			1.5		
	690SB035	ND			2		
Trichloroethene (TCE)	690SB001	3.7	58000	NA	NT	30	NA
	690SB002	14			NT		
	690SB004	5			NT		
	690SB006	8			NT		
Trichlorofluoromethane(CFC-11)	690SB002	3.4	2300000	NA	NT	10000	NA
Xylene (total)	690SB034	2.5	16000000	NA	2.9	70000	NA
	690SB035	ND			9.3		
Semivolatile Organic Compounds (μg/kg)							
Acenaphthene	690SB007	210	470000	NA	NT	290000	NA
Acetophenone	690SB020	51	780000	NA	NT	0.12	NA
4-Aminobiphenyl	690SB020	60	2.8	NA	NT	NA	NA
Anthracene	690SB007	340	2300000	NA	NT	5900000	NA
	690SB018	110			NT		
	690SB031	52			NT		
	690SB042	17			NT		

Table 10.10.4
AOC 689/690
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Benzoic acid	690SB006	25000	31000000	NA	NT	200000	NA
Benzo(g,h,i)perylene	690SB007	240	310000	NA	NT	1.2e+08	NA
	690SB018	430			NT		
	690SB042	85			NT		
Benzo(a)pyrene Equivalents (BEQs)	690SB002	9.4732	87	NA	NT	1600	NA
	690SB007	858.65			NT		
	690SB010	317.63			NT		
	690SB012	78.353			NT		
	690SB014	57.656			ND		
	690SB015	74.1695			17.788		
	690SB016	4.64			NT		
	690SB018	1788.6			NT		
	690SB019	5.98			NT		
	690SB020	60.981			NT		
	690SB021	7.566			NT		
	690SB022	0.39			ND		
	690SB029	103.57			140		
	690SB031	743.76			NT		
	690SB032	364.99			NT		
	690SB042	245.23			NT		

Table 10.10.4
AOC 689/690
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Benzo(a)anthracene	690SB002	52.8	870	NA	NT	800	NA
	690SB007	690			NT		
	690SB010	250			NT		
	690SB015	53.5			66		
	690SB018	**1500**			NT		
	690SB020	46			NT		
	690SB029	ND			110		
	690SB031	690			NT		
	690SB032	360			NT		
	690SB042	210			NT		
Benzo(a)pyrene	690SB007	**570**	87	NA	NT	4000	NA
	690SB010	**240**			NT		
	690SB012	65			NT		
	690SB014	47			ND		
	690SB015	58			ND		
	690SB018	**1200**			NT		
	690SB020	47			NT		
	690SB029	79			**110**		
	690SB031	**530**			NT		
	690SB032	**260**			NT		
	690SB042	**160**			NT		

Table 10.10.4
AOC 689/690
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Benzo(b)fluoranthene	690SB002	41.2	870	NA	NT	2500	NA
	690SB004	86			NT		
	690SB007	690			NT		
	690SB010	480			NT		
	690SB012	120			NT		
	690SB014	96			ND		
	690SB015	97			100		
	690SB016	42			NT		
	690SB018	**2400**			NT		
	690SB019	54			NT		
	690SB020	84			NT		
	690SB021	68			NT		
	690SB029	220			170		
	690SB031	**1300**			NT		
	690SB032	620			NT		
	690SB042	260			NT		

Table 10.10.4
AOC 689/690
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Benzo(k)fluoranthene	690SB007	400	8700	NA	NT	25000	NA
	690SB010	410			NT		
	690SB012	130			NT		
	690SB014	100			ND		
	690SB015	104.5			110		
	690SB016	44			NT		
	690SB018	2600			NT		
	690SB019	58			NT		
	690SB020	89			NT		
	690SB021	72			NT		
	690SB022	39			ND		
	690SB029	240			190		
	690SB031	1400			NT		
	690SB032	660			NT		
	690SB042	100			NT		
Chrysene	690SB002	73.2	87000	NA	NT	80000	NA
	690SB007	650			NT		
	690SB010	530			NT		
	690SB012	53			NT		

Table 10.10.4
AOC 689/690
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Chrysene (Continued)	690SB014	56			ND		
	690SB015	74.5			88		
	690SB018	1600			NT		
	690SB020	91			NT		
	690SB021	46			NT		
	690SB029	170			100		
	690SB031	760			NT		
	690SB032	390			NT		
	690SB042	230			NT		
Dibenz(a,h)anthracene	690SB007	**120**	87	NA	NT	800	NA
	690SB018	**130**			NT		
	690SB042	28			NT		
Indeno(1,2,3-cd)pyrene	690SB007	260	870	NA	NT	7000	NA
	690SB018	410			NT		
	690SB042	90			NT		
Benzyl alcohol	690SB039	370	2300000	NA	ND	25000	NA
Butylbenzylphthalate	690SB034	97	1600000	NA	ND	930000	NA
Chlorobenzilate	690SB002	45.8	2400	NA	NT	100	NA

Table 10.10.4
AOC 689/690
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Dibenzofuran	690SB002	103	31000	NA	NT	6800	NA
	690SB018	50			NT		
	690SB020	60			NT		
	690SB031	170			NT		
	690SB042	20			NT		
Di-n-butylphthalate	690SB013	57	780000	NA	NT	2300000	NA
	690SB014	52			49		
	690SB015	63			NT		
	690SB017	51			NT		
	690SB018	47			NT		
	690SB019	45			NT		
	690SB021	41			NT		
	690SB022	54			130		
	690SB023	81			46		
	690SB024	79			NT		
	690SB026	120			140		
	690SB027	65			NT		
	690SB028	50			86		

Table 10.10.4
AOC 689/690
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
bis(2-Ethylhexyl)phthalate (BEHP)	690SB001	130	46000	NA	NT	1800000	NA
	690SB010	1200			NT		
	690SB011	44			NT		
	690SB014	ND			110		
	690SB015	57			ND		
	690SB016	76			NT		
	690SB018	240			NT		
	690SB019	270			NT		
	690SB020	160			NT		
	690SB021	150			NT		
	690SB031	78			NT		
	690SB032	1300			NT		
Fluoranthene	690SB001	95	310000	NA	NT	2100000	NA
	690SB002	72			NT		
	690SB004	100			NT		
	690SB007	1500			NT	Q	
	690SB010	240			NT		
	690SB012	49			NT		
	690SB014	54			ND		
	690SB015	110			87		

Table 10.10.4
AOC 689/690
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Fluoranthene (Continued)	690SB017	18			NT		
	690SB018	2600			NT		
	690SB019	47			NT		
	690SB020	55			NT		
	690SB029	86			74		
	690SB031	1700			NT		
	690SB032	550			NT		
	690SB034	22			ND		
	690SB036	ND			22		
	690SB041	20			NT		
	690SB042	370			NT		
Fluorene	690SB007	160	310000	NA	NT	280000	NA
1-Methylnaphthalene	690SB011	47	31000	NA	NT	72000	NA
	690SB015	58			ND		
	690SB018	170			NT		
	690SB020	290			NT		
	690SB029	77			NT		
	690SB031	760			NT		
	690SB032	110			NT		

Table 10.10.4
AOC 689/690
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
2-Methylnaphthalene	690SB002	397	310000	NA	NT	230000	NA
	690SB018	100			NT		
	690SB020	190			NT		
	690SB029	39			ND		
	690SB031	690			NT		
	690SB032	80			NT		
	690SB034	50			ND		
Naphthalene	690SB002	205.5	310000	NA	NT	42000	NA
	690SB018	93			NT		
	690SB020	160			NT		
	690SB031	540			NT		
	690SB032	72			NT		
Phenanthrene	690SB002	225.5	230000	NA	NT	660000	NA
	690SB007	1300			NT		
	690SB015	63			ND		
	690SB017	12			NT		
	690SB018	950			NT		
	690SB020	130			NT		
	690SB029	54			NT		
	690SB031	920			NT		

Table 10.10.4
AOC 689/690
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Phenanthrene (Continued)	690SB032	160			NT		
	690SB034	34			ND		
	690SB042	160			NT		
Pyrene	690SB002	74.4	230000	NA	NT	2100000	NA
	690SB004	110			NT		
	690SB007	1200			NT		
	690SB010	300			NT		
	690SB011	44			NT		
	690SB012	51			NT		
	690SB014	50			ND		
	690SB015	84			68		
	690SB018	2200			NT		
	690SB019	47			NT		
	690SB020	75			NT		
	690SB029	190			100		
	690SB031	1000			NT		
	690SB032	580			NT		
	690SB034	19			ND		
	690SB036	ND			18		
	690SB041	15			NT		
	690SB042	260			NT		

Table 10.10.4
AOC 689/690
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Pesticides/PCBs (μg/kg)							
Aldrin	690SB011	2.7	38	NA	NT	230	NA
	690SB013	1.9			NT		
Aroclor-1260	690SB005	39	320	NA	NT	1000	NA
	690SB007	58			NT		
	690SB010	95			NT		
	690SB015	ND			73		
	690SB016	95			NT		
	690SB019	87			NT		
	690SB021	170			NT		
beta-BHC (beta-HCH)	690SB013	1.5	350	NA	NT	1.3	NA
	690SB015	1.8			1.9		
	690SB021	2.7			NT		
delta-BHC (delta-HCH)	690SB026	7.4	350	NA	NT	1.8	NA
	690SB030	2.3			NT		
gamma-BHC (Lindane)	690SB011	1.2	490	NA	NT	4.5	NA
	690SB023	3.7			NT		
Chlordane	690SB022	7.6	1800	NA	NT	5000	NA
alpha-Chlordane	690SB002	2.3	1800	NA	NT	5000	NA
gamma-Chlordane	690SB008	4	1800	NA	NT	5000	NA

Table 10.10.4
AOC 689/690
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
4,4'-DDD	690CB002	3.7	2700	NA	NT	8000	NA
	690SB011	14			NT		
	690SB021	26			NT		
4,4'-DDE	690CB002	2.4	1900	NA	NT	27000	NA
	690SB006	16			NT		
	690SB008	3			NT		
	690SB010	3			NT		
	690SB019	9.5			NT		
	690SB020	12			NT		
	690SB021	60			NT		
	690CB026	22.5			NT		
	690SB029	23			ND		
Dieldrin	690SB002	11.1	40	NA	NT	2	NA
Endosulfan I	690SB013	2	47000	NA	NT	9000	NA
	690SB018	33			NT		
	690SB019	2			NT		
	690SB029	4.5			ND		
Endosulfan II	690SB002	6.1	47000	NA	NT	9000	NA
	690SB015	7			ND		
	690SB028	ND			4.5		
Endosulfan sulfate	690SB018	2.7	47000	NA	NT	4600	NA

Table 10.10.4
AOC 689/690
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Endrin	690SB018	5.6	2300	NA	NT	500	NA
Endrin aldehyde	690SB022	1.9	2300	NA	ND	340	NA
	690SB025	1.2			NT		
Heptachlor	690SB002	3.1	140	NA	NT	11000	NA
	690SB011	1.2			NT		
	690SB018	2.1			NT		
Heptachlor epoxide	690SB014	1.4	70	NA	ND	330	NA
	690SB020	1.5			NT		
Methoxychlor	690SB011	2.8	39000	NA	NT	80000	NA
	690SB018	75			NT		
	690SB029	6.5			ND		
Organophosphate Pesticides (μg/kg)							
Methyl parathion	690SB015	28	2000	NA	NT	150	NA
Herbicides (μg/kg)							
2,4,5-T	690SB002	6.3	78000	NA	NT	990	NA
	690SB015	13			NT		
	690SB026	1.4			NT		
Organotin (μg/kg)							
Dibutyltin	690SB020	6.66	2300	NA	NT	NA	NA
	690SB028	ND			6.65		
Monobutyltin	690SB028	ND	2300	NA	8.16	NA	NA

Table 10.10.4
AOC 689/690
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Tributyltin	690SB028	ND	2300	NA	7.64	NA	NA
TPH (mg/kg)							
Petroleum hydrocarbons, TPH	690SB009	140	NA	NA	NT	NA	NA
	690SB010	820			NT		
Dioxin Compounds (ng/kg)							
2,3,7,8-TCDD equivalents (TEQs)	690SB002	3.904	4.3	NA	NT	1600	NA
	690SB011	0.454			NT		
	690SB012	0.456			NT		
	690SB013	2.213			NT		
	690SB014	0.844			0.258		
	690SB015	0.518			NT		
	690SB016	0.257			NT		
	690SB017	0.382			NT		
	690SB018	1.963			NT		
	690SB019	0.544			NT		
	690SB020	0.265			NT		
	690SB021	0.791			NT		
	690SB022	0.526			0.185		
	690SB023	0.044			0.0196		
	690SB024	0.237			NT		

Table 10.10.4
AOC 689/690
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
2,3,7,8-TCDD equivalents (TEQs) (Contd.)	690SB025	0.106			NT		
	690SB026	0.253			0.0586		
	690SB027	0.253			NT		
	690SB028	0.204			0.0133		
	690SB029	0.282			0.3498		
	690SB030	0.139			NT		
123478-HxCDD	690SB002	1.5211	43	NA	NT	4100	NA
123678-HxCDD	690SB002	2.5723	43	NA	NT	4100	NA
	690SB018	1.99			NT		
123789-HxCDD	690SB002	2.5638	43	NA	NT	4100	NA
	690SB026	1.086			NT		
1234678-HpCDD	690SB002	70.1093	430	NA	NT	108000	NA
	690SB011	14.141			NT		
	690SB012	11.039			NT		
	690SB013	71.613			NT		
	690SB014	29.497			5.399		
	690SB015	15.904			NT		
	690SB016	9.461			NT		
	690SB017	11.994			NT		

Table 10.10.4
AOC 689/690
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
1234678-HpCDD (Continued)	690SB018	53.714			NT		
	690SB019	20.811			NT		
	690SB020	6.514			NT		
	690SB021	23.085			NT		
	690SB022	17.807			2.287		
	690SB023	0.807			0.771		
	690SB024	3.013			NT		
	690SB025	4.624			NT		
	690SB026	5.483			1.015		
	690SB027	8.658			NT		
	690SB028	8.168			0.652		
	690SB029	6.952			14.505		
	690SB030	5.973			NT		
OCDD	690SB002	830.5579	4300	NA	NT	1080000	NA
	690SB011	166.961			NT		
	690SB012	260.579			NT		
	690SB013	817.968			NT		
	690SB014	343.255			69.635		
	690SB015	177.3115			NT		
	690SB016	71.283			NT		

Table 10.10.4
AOC 689/690
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
OCDD (Continued)	690SB017	94.934			NT		
	690SB018	409.38			NT		
	690SB019	138.593			NT		
	690SB020	58.435			NT		
	690SB021	285.492			NT		
	690SB022	184.79			161.84		
	690SB023	36.346			8.664		
	690SB024	195.97			NT		
	690SB025	47.644			NT		
	690SB026	80.0745			11.28		
	690SB027	112.57			NT		
	690SB028	116.96			6.819		
	690SB029	127.308			203.35		
	690SB030	72.789			NT		
2378-TCDF	690SB002	2.2699	43	NA	NT	200	NA
	690SB018	3.553			NT		
12378-PeCDF	690SB002	2.3182	85	NA	NT	800	NA
23478-PeCDF	690SB002	1.3434	8.5	NA	NT	100	NA

Table 10.10.4
AOC 689/690
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
123478-HxCDF	690SB002	2.9479	43	NA	NT	216000	NA
	690SB013	2.618			NT		
	690SB014	ND			0.748		
	690SB017	1.203			NT		
	690SB018	2.745			NT		
	690SB020	1.268			NT		
	690SB022	0.789			ND		
	690SB027	0.451			NT		
123678-HxCDF	690SB002	1.0544	43	NA	NT	216000	NA
	690SB011	1.014			NT		
	690SB012	0.72			NT		
	690SB013	3.013			NT		
	690SB014	1.729			NT		
	690SB015	1.479			NT		
	690SB016	0.652			NT		
	690SB019	1.231			NT		
	690SB021	1.891			NT		
	690SB029	0.678			ND		
123789-HxCDF	690SB002	0.656	43	NA	NT	216000	NA
	690SB026	ND			0.338		

Table 10.10.4
AOC 689/690
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
234678-HxCDF	690SB002	1.1878	43	NA	NT	216000	NA
1234678-HpCDF	690SB002	8.1095	430	NA	NT	54000	NA
	690SB011	3.922			NT		
	690SB012	1.235			NT		
	690SB013	9.623			NT		
	690SB014	2.851			5.055		
	690SB015	2.8825			NT		
	690SB016	2.388			NT		
	690SB017	4.2			NT		
	690SB018	16.722			NT		
	690SB019	6.575			NT		
	690SB020	1.332			NT		
	690SB021	6.727			NT		
	690SB022	2.84			ND		
	690SB023	ND			0.322		
	690SB024	0.866			NT		
	690SB025	0.997			NT		
	690SB026	0.889			0.345		
	690SB027	0.677			NT		
	690SB028	0.455			ND		
	690SB029	1.429			ND		
	690SB030	0.653			NT		

Table 10.10.4
AOC 689/690
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
OCDF	690SB002	26.3055	4300	NA	NT	540000	NA
	690SB011	4.931			NT		
	690SB012	1.113			NT		
	690SB013	19.685			NT		
	690SB014	4.08			8.68		
	690SB015	5.0005			NT		
	690SB016	2.188			NT		
	690SB017	5.22			NT		
	690SB018	20.654			NT		
	690SB019	8.456			NT		
	690SB020	1.256			NT		
	690SB021	18.454			NT		
	690SB022	7.059			ND		
	690SB024	2.081			NT		
	690SB025	2.037			NT		
	690SB026	0.803			ND		
	690SB027	1.752			NT		
	690SB028	0.473			ND		
	690SB029	3.263			1.428		

Table 10.10.4
AOC 689/690
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Inorganics (mg/kg)							
Aluminum (Al)	690SB001	5130	7800	27400	NT	560000	18900
	690SB002	2490			NT		
	690SB003	920			NT		
	690SB004	8880			NT		
	690SB005	3660			NT		
	690SB006	6680			NT		
	690SB007	4980			NT		
	690SB008	1580			NT		
	690SB009	2950			NT		
	690SB010	6270			NT		
	690SB011	12700			NT		
	690SB012	7660			NT		
	690SB013	22400			NT		
	690SB014	13100			13200		
	690SB015	12150			10100		
	690SB016	5850			NT		
	690SB017	3560			NT		
	690SB018	4580			NT		
	690SB019	4090			NT		

Table 10.10.4
AOC 689/690
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Aluminum (Al) (Continued)	690SB020	6830			NT		
	690SB021	5810			NT		
	690SB022	3350			11400		
	690SB023	12000			6710		
	690SB024	2980			NT		
	690SB025	5700			NT		
	690SB026	12000			8710		
	690SB027	22000			NT		
	690SB028	12800			6370		
	690SB029	6440			**21600**		
	690SB030	8340			NT		
	690SB034	7880			**22500**		
	690SB035	5690			7670		
	690SB036	18100			12200		
	690SB037	2025			16400		
	690SB038	7880			11200		
	690SB039	6630			**20100**		
	690SB040	9320			8730		
	690SB041	5170			NT		
	690SB042	3680			NT		

Table 10.10.4
AOC 689/690
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Antimony (Sb)	690SB022	0.28	3.1	ND	ND	2.7	ND
	690SB034	**24.5**			ND		
	690SB037	0.46			NT		
	690SB039	0.57			ND		
Arsenic (As)	690SB001	7.5	0.43	21.6	NT	15	6.45
	690SB002	**26.3**			NT		
	690SB003	1.7			NT		
	690SB004	11.2			NT		
	690SB005	5.8			NT		
	690SB006	2.1			NT		
	690SB007	2.2			NT		
	690SB008	4.7			NT		
	690SB009	3.6			NT		
	690SB010	7.4			NT		
	690SB011	6.7			NT		
	690SB012	9.8			NT		
	690SB013	9.2			NT		
	690SB014	6.4			**6.7**		
	690SB015	9.7			**8.2**		
	690SB016	1.9			NT		
	690SB017	3.6			NT		
	690SB018	10.7			NT		

Table 10.10.4
AOC 689/690
Analytes Detected in Surface and Subsurface Soil

Parameter		Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Arsenic (As)	(Continued)	690SB019	1.3			NT		
		690SB020	11.8			NT		
		690SB021	6.7			NT		
		690SB022	ND			7.1		
		690SB023	7.9			4.2		
		690SB025	2.6			NT		
		690SB026	5.5			5.2		
		690SB027	8.2			NT		
		690SB028	7			4.2		
		690SB029	28.7			13		
		690SB030	5.3			NT		
		690SB034	10			9.9		
		690SB035	7.5			6.5		
		690SB036	10.9			9.8		
		690SB037	3.35			11.4		
		690SB038	1.5			8.8		
		690SB039	1.5			12.3		
		690SB040	3.7			9.7		
		690SB041	2.3			NT		
		690SB042	2.8			NT		

Table 10.10.4
AOC 689/690
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Barium (Ba)	690SB002	17.9	550	54.2	NT	820	36
	690SB011	23.2			NT		
	690SB012	22.7			NT		
	690SB013	33.1			NT		
	690SB014	28			17		
	690SB015	42.6			23		
	690SB016	17.1			NT		
	690SB017	10.4			NT		
	690SB018	39.9			NT		
	690SB019	203			NT		
	690SB020	37.1			NT		
	690SB021	20.5			NT		
	690SB022	9			15.5		
	690SB023	16.9			10.4		
	690SB024	5.6			NT		
	690SB025	17.8			NT		
	690SB026	19.3			14.8		
	690SB027	28.6			NT		
	690SB028	17.1			11.1		

Table 10.10.4
AOC 689/690
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Barium (Ba) (Continued)	690SB029	27.5			29.5		
	690SB030	17			NT		
	690SB034	34.8			33.6		
	690SB035	13.1			12.6		
	690SB036	29.7			18.5		
	690SB037	9.7			29.8		
	690SB038	13.1			25.1		
	690SB039	11.2			31.4		
	690SB040	20.5			22.6		
	690SB041	16.4			NT		
	690SB042	43.7			NT		
Beryllium (Be)	690SB002	0.57	16	0.95	NT	32	0.67
	690SB022	ND			0.39		
	690SB023	0.47			0.35		
	690SB026	1			0.47		
	690SB027	0.68			NT		
	690SB028	ND			0.36		
	690SB034	0.63			1.8		
	690SB035	0.39			0.49		
	690SB036	0.84			0.79		

Table 10.10.4
AOC 689/690
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Beryllium (Be) (Continued)	690SB037	ND			0.86		
	690SB038	ND			0.7		
	690SB039	ND			1		
	690SB040	ND			0.53		
	690SB042	0.43			NT		
Cadmium (Cd)	690SB002	0.3	7.8	0.61	NT	4	0.54
	690SB021	1			NT		
	690SB022	ND			0.22		
	690SB023	0.07			0.52		
	690SB026	0.45			0.49		
	690SB027	0.58			NT		
	690SB028	0.57			0.61		
	690SB030	0.6			NT		
	690SB034	0.7			0.52		
	690SB035	0.94			0.5		
	690SB037	0.605			NT		
	690SB042	0.52			NT		
Chromium (Cr) (total)	690SB001	22.5	39	34.5	NT	19	51.3
	690SB002	19.85			NT		
	690SB003	7.7			NT		

Table 10.10.4
AOC 689/690
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Chromium (Cr) (total) (Continued)	690SB004	25.7			NT		
	690SB005	132			NT		
	690SB006	21.2			NT		
	690SB007	9.5			NT		
	690SB008	11.9			NT		
	690SB009	66.2			NT		
	690SB010	48			NT		
	690SB011	36.4			NT		
	690SB012	19.7			NT		
	690SB013	55.9			NT		
	690SB014	31.4			26.8		
	690SB015	32.5			24.4		
	690SB016	131			NT		
	690SB017	33.4			NT		
	690SB018	29.4			NT		
	690SB019	42.7			NT		
	690SB020	26.5			NT		
	690SB021	19.3			NT		
	690SB022	6.5			21.6		

Table 10.10.4
AOC 689/690
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Chromium (Cr) (total) (Continued)	690SB023	21.8			43.9		
	690SB024	4.1			NT		
	690SB025	10.3			NT		
	690SB026	57.6			36.4		
	690SB027	38.1			NT		
	690SB028	27.6			35		
	690SB029	19.3			33.2		
	690SB030	21.2			NT		
	690SB034	58.7			49.8		
	690SB035	45.4			37.1		
	690SB036	43.7			33.3		
	690SB037	10.85			35.9		
	690SB038	14.3			27.4		
	690SB039	13.9			51.7		
	690SB040	28.3			21.5		
	690SB041	10.4			NT		
	690SB042	40			NT		
Chromium (Cr6) (hexavalent)	690SB015	3.98	39	ND	NT	19	ND
	690SB026	0.512			NT		

Table 10.10.4
AOC 689/690
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Cobalt (Co)	690SB011	3	470	5.8	NT	990	3.48
	690SB013	4.6			NT		
	690SB014	2.8			2.4		
	690SB015	4.05			2.6		
	690SB018	2.9			NT		
	690SB020	2.6			NT		
	690SB021	1.9			NT		
	690SB022	0.48			2.8		
	690SB023	2.8			1		
	690SB024	0.32			NT		
	690SB025	1.6			NT		
	690SB026	3.4			2.3		
	690SB027	4			NT		
	690SB028	2.3			0.99		
	690SB029	3.9			5.4		
	690SB030	2.5			NT		
	690SB034	3.8			5		
	690SB035	2.1			1.5		
	690SB036	4.6			3		

Table 10.10.4
AOC 689/690
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Cobalt (Co) (Continued)	690SB037	3.25			4.5		
	690SB038	1.5			3.2		
	690SB039	1.2			5.5		
	690SB040	2.9			2.5		
	690SB041	1.9			NT		
	690SB042	3			NT		
Copper (Cu)	690SB001	87.6	310	240	NT	5600	11.5
	690SB002	35.45			NT		
	690SB004	46.5			NT		
	690SB005	87.3			NT		
	690SB008	24.2			NT		
	690SB010	**321**			NT		
	690SB011	37.1			NT		
	690SB012	16.1			NT		
	690SB013	32.5			NT		
	690SB014	20.4			15.7		
	690SB015	20.25			14.3		
	690SB016	35.8			NT		
	690SB017	15.2			NT		
	690SB018	74.4			NT		

Table 10.10.4
AOC 689/690
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Copper (Cu) (Continued)	690SB019	90.7			NT		
	690SB020	18.5			NT		
	690SB021	23			NT		
	690SB022	2.1			10.5		
	690SB023	9.3			13.2		
	690SB024	0.72			NT		
	690SB025	16.7			NT		
	690SB026	17.3			10.9		
	690SB027	25.2			NT		
	690SB028	14			12.9		
	690SB029	22.3			30.2		
	690SB030	12.6			NT		
	690SB034	123			10.3		
	690SB035	37.4			8.6		
	690SB036	20.8			7.7		
	690SB037	8.85			18.2		
	690SB038	12.7			15.9		
	690SB039	15.2			22.8		
	690SB040	28.1			10.1		
	690SB041	15.8			NT		
	690SB042	305			NT		

Table 10.10.4
AOC 689/690
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Lead (Pb)	690SB001	27.6	400	203	NT	400	12.3
	690SB002	30.05			NT		
	690SB004	30.7			NT		
	690SB005	94.1			NT		
	690SB006	24.9			NT		
	690SB007	9			NT		
	690SB008	12.9			NT		
	690SB009	33.7			NT		
	690SB010	118			NT		
	690SB011	35.8			NT		
	690SB012	17.6			NT		
	690SB013	32			NT		
	690SB014	20.8			8		
	690SB015	165.5			14.3		
	690SB016	28			NT		
	690SB017	7.2			NT		
	690SB018	37			NT		
	690SB019	44.7			NT		
	690SB020	20.8			NT		
	690SB021	173			NT		

Table 10.10.4
AOC 689/690
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Lead (Pb) (Continued)	690SB022	8			9.6		
	690SB023	32.2			2.5		
	690SB024	2.8			NT		
	690SB025	9.8			NT		
	690SB026	7			3.1		
	690SB027	19			NT		
	690SB028	10.3			4.4		
	690SB029	24.5			43.3		
	690SB030	12.8			NT		
	690SB034	132			10.5		
	690SB035	14.8			4.7		
	690SB036	21.5			8.7		
	690SB037	13.05			19.5		
	690SB038	12.5			15.9		
	690SB039	10.7			26.1		
	690SB040	21.6			10.8		
	690SB041	11.1			NT		
	690SB042	122			NT		
Manganese (Mn)	690SB001	143	160	419	NT	480	118
	690SB002	36.9			NT		
	690SB003	199			NT		

Table 10.10.4
AOC 689/690
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Manganese (Mn) (Continued)	690SB004	245			NT		
	690SB005	162			NT		
	690SB006	62.7			NT		
	690SB007	58.6			NT		
	690SB008	203			NT		
	690SB009	147			NT		
	690SB010	135			NT		
	690SB011	178			NT		
	690SB012	60.4			NT		
	690SB013	289			NT		
	690SB014	111			90.8		
	690SB015	281.5			163		
	690SB016	54.4			NT		
	690SB017	25.8			NT		
	690SB018	76.3			NT		
	690SB019	82.2			NT		
	690SB020	77.5			NT		
	690SB021	113			NT		
	690SB022	14			95.8		

Table 10.10.4
AOC 689/690
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Manganese (Mn) (Continued)	690SB023	150			69.7		
	690SB024	8.7			NT		
	690SB025	83.2			NT		
	690SB026	54.2			77.2		
	690SB027	196			NT		
	690SB028	125			65.3		
	690SB029	172			**341**		
	690SB030	142			NT		
	690SB034	112			139		
	690SB035	106			60.8		
	690SB036	**461**			152		
	690SB037	268			**315**		
	690SB038	42.9			**267**		
	690SB039	26			**400**		
	690SB040	152			**217**		
	690SB041	36.8			NT		
	690SB042	125			NT		

Table 10.10.4
AOC 689/690
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Mercury (Hg)	690SB001	0.06	2.3	0.47	NT	1	ND
	690SB002	0.05			NT		
	690SB004	0.04			NT		
	690SB005	0.07			NT		
	690SB006	0.05			NT		
	690SB007	0.05			NT		
	690SB010	0.55			NT		
	690SB012	0.23			NT		
	690SB013	0.17			NT		
	690SB014	0.3			0.15		
	690SB015	0.155			0.16		
	690SB016	0.15			NT		
	690SB018	0.16			NT		
	690SB019	0.39			NT		
	690SB021	0.23			NT		
	690SB027	0.15			NT		
	690SB028	ND			0.16		
	690SB029	ND			0.2		
	690SB034	0.11			0.04		
	690SB035	0.09			0.02		

Table 10.10.4
AOC 689/690
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Mercury (Hg) (Continued)	690SB036	0.12			0.03		
	690SB037	0.02			0.12		
	690SB038	0.03			0.12		
	690SB039	0.03			0.17		
	690SB040	0.06			0.07		
	690SB041	0.02			NT		
	690SB042	0.67			NT		
Nickel (Ni)	690SB001	11.2	160	23.9	NT	65	15.7
	690SB002	10.9			NT		
	690SB004	12.9			NT		
	690SB005	15.6			NT		
	690SB008	10.2			NT		
	690SB010	62.3			NT		
	690SB011	14.4			NT		
	690SB012	6.6			NT		
	690SB013	15.5			NT		
	690SB014	11			10.7		
	690SB015	10.8			6.7		
	690SB016	7.5			NT		
	690SB017	14.3			NT		

Table 10.10.4
AOC 689/690
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Nickel (Ni) (Continued)	690SB018	17.8			NT		
	690SB019	19.3			NT		
	690SB020	13.1			NT		
	690SB021	10.7			NT		
	690SB022	1.4			10.7		
	690SB023	6.1			18		
	690SB024	0.56			NT		
	690SB025	5.4			NT		
	690SB026	14.9			13		
	690SB027	14.6			NT		
	690SB028	10.5			10.7		
	690SB029	13.7			11.5		
	690SB030	10.9			NT		
	690SB034	41.1			28		
	690SB035	41.7			13.5		
	690SB036	13.1			10.7		
	690SB037	10.65			11.8		
	690SB038	4.9			8.4		
	690SB039	4.1			13.9		
	690SB040	7.9			6.7		
	690SB041	4.2			NT		
	690SB042	20.7			NT		

Table 10.10.4
AOC 689/690
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Selenium (Se)	690SB001	0.34	39	1.49	NT	2.6	1.77
	690SB002	0.55			NT		
	690SB003	0.11			NT		
	690SB004	0.27			NT		
	690SB005	0.27			NT		
	690SB006	0.29			NT		
	690SB007	0.16			NT		
	690SB009	0.17			NT		
	690SB010	0.81			NT		
	690SB012	1			NT		
	690SB013	1.1			NT		
	690SB014	1.2			0.8		
	690SB015	1.04			0.84		
	690SB016	0.48			NT		
	690SB017	1.6			NT		
	690SB018	1.3			NT		
	690SB019	0.63			NT		
	690SB020	1.2			NT		
	690SB022	ND			1.2		
	690SB023	0.78			1.4		

Table 10.10.4
AOC 689/690
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Selenium (Se) (Continued)	690SB024	0.65			NT		
	690SB026	1			1.2		
	690SB027	0.8			NT		
	690SB028	1.1			1.4		
	690SB029	0.89			ND		
	690SB030	0.7			NT		
	690SB034	0.73			0.67		
	690SB035	1.2			1.4		
	690SB036	0.83			1.1		
	690SB037	ND			0.74		
	690SB039	ND			0.9		
	690SB042	0.54			NT		
Tin (Sn)	690SB011	10.3	4700	7.5	NT	5500	ND
	690SB012	1			NT		
	690SB019	10.4			NT		
	690SB021	0.96			NT		
	690SB025	1.4			NT		
	690SB034	14.6			1.2		
	690SB035	2			1.3		
	690SB040	4.3			ND		
	690SB041	2.8			NT		
	690SB042	11.4			NT		

Table 10.10.4
AOC 689/690
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Vanadium (V)	690SB001	15.5	55	113	NT	3000	38.1
	690SB002	11.55			NT		
	690SB004	26.9			NT		
	690SB005	12.6			NT		
	690SB006	8.9			NT		
	690SB009	9.6			NT		
	690SB010	24.1			NT		
	690SB011	25.2			NT		
	690SB012	21.3			NT		
	690SB013	47.7			NT		
	690SB014	27.9			21.7		
	690SB015	35.35			26.4		
	690SB016	12.1			NT		
	690SB017	21.4			NT		
	690SB018	18.9			NT		
	690SB019	38.9			NT		
	690SB020	20.8			NT		
	690SB021	14.1			NT		
	690SB022	5.5			23.5		
	690SB023	25.8			27		

Table 10.10.4
AOC 689/690
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Vanadium (V) (Continued)	690SB024	3.4			NT		
	690SB025	9.2			NT		
	690SB026	34.2			21.5		
	690SB027	37.3			NT		
	690SB028	23.7			19.7		
	690SB029	17.8			49.1		
	690SB030	17.6			NT		
	690SB034	25			45.4		
	690SB035	24.7			24.5		
	690SB036	45.3			29.5		
	690SB037	9.2			42.5		
	690SB038	11.5			31.7		
	690SB039	8.3			53.3		
	690SB040	18.9			24		
	690SB041	8.4			NT		
	690SB042	10.1			NT		
Zinc (Zn)	690SB001	65.5	2300	206	NT	6200	36.2
	690SB002	56.4			NT		
	690SB004	107			NT		
	690SB005	146			NT		

Table 10.10.4
AOC 689/690
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Zinc (Zn) (Continued)	690SB006	45.7			NT		
	690SB008	45.5			NT		
	690SB009	76.2			NT		
	690SB010	252			NT		
	690SB011	59.4			NT		
	690SB012	38.9			NT		
	690SB013	69.6			NT		
	690SB014	66.3			28.1		
	690SB015	49.4			30.9		
	690SB016	43.2			NT		
	690SB017	32.1			NT		
	690SB018	63.6			NT		
	690SB019	162			NT		
	690SB020	36.8			NT		
	690SB021	60.1			NT		
	690SB022	14			29.1		
	690SB023	33.8			35.1		
	690SB024	2.6			NT		
	690SB025	23.3			NT		
	690SB026	51.8			25.3		

Table 10.10.4
AOC 689/690
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Zinc (Zn) (Continued)	690SB027	50.2			NT		
	690SB028	34.4			26		
	690SB029	47.4			78.2		
	690SB030	38.2			NT		
	690SB034	152			71.9		
	690SB035	319			40		
	690SB036	63.6			33.5		
	690SB037	35.65			52.2		
	690SB038	34			42.6		
	690SB039	34.1			66.4		
	690SB040	68.9			30.4		
	690SB041	22.3			NT		
	690SB042	184			NT		

Notes:

*	=	Residential RBCs (THQ=0.1) were used as a reference concentration for upper-interval samples. Generic soil-to groundwater SSLs (DAF=10) from *Soil Screening Guidance: Technical Background Document* (USEPA, 1996b) were used as s reference concentration for lower-interval samples.

Bold concentrations exceed both the RBC and the zone background.
All background values for Zone I are based on twice the means of the grid sample concentrations.

NA	=	Not applicable/not available
ND	=	Not detected
NT	=	Not taken
RBC	=	Risk-based concentration
SSL	=	Soil screening level
Ng/kg	=	Nanograms per kilogram
mg/kg	=	Micrograms per kilogram
pg/L	=	Picograms per liter
μG/L	=	Micrograms per liter
mg/L	=	Milligrams per liter
THQ	=	Target hazard quotient
DAF	=	Dilution attenuation factor

Volatile Organic Compounds in Soil

Fourteen VOCs were detected in soil at AOCs 689 and 690. Nine of 14 VOCs were detected only once or twice. Toluene was the most common VOC detected; it was found in 10 of 39 upper-interval samples. Toluene was also detected in grid boring GDISB00201 at 3.0 μg/kg. No other VOCs were detected in the grid boring. All VOC detections were far below their respective RBCs or SSLs.

Semivolatile Organic Compounds in Soil

Of the 26 SVOCs detected in soil at AOCs 689 and 690, four exceeded their respective RBCs.

Benzo(a)anthracene was detected in nine of 42 upper-interval samples at concentrations ranging from 46 μg/kg to 1,500 μg/kg. The maximum concentration of 1,500 μg/kg was detected in sample 690SB01801.

Benzo(a)pyrene was detected in 11 of 42 upper-interval samples and one of 14 lower-interval samples. Six samples in the upper-interval exceeded the benzo(a)pyrene RBC. The maximum concentration was detected in sample 690SB01801 (1,200 μg/kg). The single detection of benzo(a)pyrene in the lower-interval did not exceed the SSL.

Sixteen of 42 surface samples had benzo(b)fluoranthene detections ranging from 41.2 μg/kg to 2,400 μg/kg. Two of the 16 detections – 2,400 μg/kg at 690SB01801 and 1,300 μg/kg at 690SB03101 – exceeded the RBC. The two detections in subsurface soil were far below the SSL.

Dibenzo(a,h)anthracene was detected in three of 42 samples, with a range of 28.0 μg/kg to 130 μg/kg. Concentrations in samples 690SB00701 (120 μg/kg) and 690SB01801 (130 μg/kg) exceeded the RBC.

In accordance with recent cPAH guidance, BEQs were calculated for cPAHs at AOCs 689 and 690. Seven BEQs exceeded the benzo(a)pyrene RBC of 87.0 μg/kg; samples 690SB01801, 690SB02901, 690SB03101, 690SB00701, 690SB01001, 690SB03201, and 690SB04201 had a range of BEQs from 103 μg/kg to 1788 μg/kg. Of the PAHs detected at AOCs 689 and 690, the highest detections, by an order of magnitude, were in sample 690SB01801. Third-round sampling was performed to determine the extent of contaminants found in 690SB01801. These samples had PAH detections exceeding their respective RBCs. However, BEQs were calculated in two subsurface samples at 17.8 μg/kg and 140 μg/kg, well below the SSL.

Three SVOCs – phenanthrene, 2-methylnaphthalene, and 1-methylnaphthalene – were detected in the surface soil sample from grid boring GDISB00201. The detections were all below respective screening levels.

Pesticides and PCBs in Soil

Of the 19 pesticides detected in soil samples at AOCs 689 and 690, none exceeded the respective RBCs. One lower-interval sample (690SB015) exceeded the beta-BHC SSL, with a detection of 1.90 μg/kg.

Aroclor-1260 was detected in six of 30 samples; however, none of the detections exceeded the RBC of 320 μg/kg.

Herbicides in Soil

One herbicide, 2,4,5-T, was detected in surface soil duplicate samples 690SB00201 and 690SB01501 at concentrations far below the RBC.

Other Organic Compounds in Soil

Three organotins were detected at AOCs 689 and 690. None exceeded the RBC of 2300 μg/kg.

Dioxins were detected in 21 of 23 samples. In accordance with recent dioxin guidance (USEPA, 1995b) and Section 7 of this report, TEQs were calculated, and they range from 4.40E-5 μg/kg to 3.90E-3 μg/kg. All calculated TEQs were below the 2,3,7,8-TCDD RBC of 4.3E-03 μg/kg. Dioxins were detected in all six subsurface samples. TEQs ranged from 1.3E-5 μg/kg to 3.49E-4 μg/kg, all below the SSL of 1.6 μg/kg.

Inorganics Elements in Soil

Twenty-three metals were detected in soil samples at AOCs 689 and 690. Five metals were detected in surface soils at concentrations exceeding their respective screening levels. Antimony was present in sample 690SB03401 at of 24.5 mg/kg, which exceeds its RBC (3.1 mg/kg). Arsenic was detected in two upper-interval samples at concentrations that exceeded the screening criteria: 690SB002 (26.3 mg/kg) and 690SB029 (28.7 mg/kg). Arsenic was also detected in grid boring GDISB00202 at 4.0 mg/kg, below the screening criteria. Chromium was detected in 11 of 39 surface samples at concentrations that exceeded its RBC and background level. Chromium was detected in one subsurface sample, 690SB039 (51.3 mg/kg), at a concentration exceeding its SSL and background level. Chromium was also detected in grid boring GDISB00201 at 25.4 mg/kg below the RBC and background. Copper was detected in one upper-interval sample (690SB010) at a concentration that exceeded its screening level. Manganese was detected in one upper-interval sample (690SB036) at a concentration that exceeded its screening level.

10.10.3 Groundwater Sampling and Analysis

No wells were installed specifically to characterize groundwater at AOCs 689 and 690. The final RFI work plan proposed five grid-based well pairs (GDI001/01D, GDI002/02D, GDI003/03D, GDI004/04D, and GDI019/19D) to be installed in the vicinity of AOCs 689 and 690 to characterize the zone perimeter groundwater. In addition, two Zone H grid well pairs (GDH010/10D and GDH011/11D) were already installed in AOCs 689/690. Four rounds of samples were collected from these wells and analyzed for VOCs, SVOC, metals, cyanide, pesticides, PCBs, chloride, sulfate, and TDS at DQO Level III. Results of these analyses are discussed below; the analytical data are included in Appendix D.

Figure 10.10.1 illustrates the grid-based wells associated with AOCs 689 and 690. All shallow monitoring wells were installed to 12.5 to 13.0 feet bgs. Deep grid wells were installed to depths of 46 ft to 62 feet bgs. All wells were installed in accordance with Section 3.3 of this report.

10.10.4 Nature and Extent of Contamination in Groundwater

Volatile Organic Compounds in Groundwater

Four VOCs were detected in groundwater samples from the shallow grid-based wells. Acetone was detected in first-round samples from wells GDI001 (9 μg/L), GDI002 (9 μg/L), and GDI003 (60 μg/L) and in the third-round sample from well GDI001 (5 μg/L). None of these detections exceeded the tap-water RBC for acetone (370 μg/L). Toluene was detected in second-round sample GDI00402 (2 μg/L), far below its RBC or MCL. Carbon disulfide and xylene were detected in the third-round sample from well GDI019, far below their respective RBCs or MCLs. Carbon disulfide was also detected in well GDH011 in the first-round, at 7.0 μg/L.

Acetone, carbon disulfide, and xylene were also detected in groundwater samples from three of the five deep grid-based wells. Acetone was detected in first-round sample GDI03D (27 μg/L). Carbon disulfide was detected in fourth-round sample GDI02D (1.0 μg/L), and third-round GDI04D (2.0 μg/L). Xylene was detected at a concentration of 2 μg/L in second-round sample GDI03D. Each of these detections was far below the corresponding RBC or MCL.

Semivolatile Organic Compounds in Groundwater

Four SVOCs were detected in the shallow grid well samples. Acetophenone was detected in first-round samples from wells GDI003 (1.0 μg/L) and GDI019 (1.0 μg/L) at concentrations exceeding the RBC of 0.0042 μg/L. However, it was not detected in any subsequent sample rounds. Bis(2-ethylhexyl)phthalate exceeded its RBC (4.8 μg/L) in the first-round sample from well GDI001 (15 μg/L). It was also detected in well GDI002 (2 μg/l) during the third-round sampling, but did not exceed the RBC. Benzoic acid was detected in the last two sampling rounds in well GDI019 and in the last round at well GDI002. These detections were far below the RBC. A concentration of 3.0 μg/L of di-n-butylphthalate, well below its RBC was detected in the first-round sample from well GDI004.

Two SVOCs, benzoic acid and diethylphthalate, were detected in deep grid-based wells. Wells GDI02D, GDI03D, and GDI019D had minor detections of benzoic acid at concentrations far below its tap-water RBC. Diethylphthalate was detected in wells GDI03D and GDI04D at concentrations far below its tap-water RBC. Bis(2-ethylhexyl)phthalate was detected in deep well GDH10D during the second-round of sampling at 9.0 μg/L.

Pesticides/PCBs in Groundwater

Heptachlor was the only pesticide detected in the shallow grid-based wells. It was detected in the first-round sample from well GDI001 (0.0015 μg/L) and did not exceed its tap-water RBC.

Two pesticides were detected in the groundwater samples collected from the deep grid-based wells. Beta-BHC and gamma-BHC were detected in the first-round sample from well GDI019D at concentrations exceeding their respective RBCs, (290 μg/L and 0.19 μg/L, respectively. Neither pesticide was detected in any subsequent sample.

Aroclor-1260 was detected in the second-round sample from well GDI01D. At a concentrations exceeding its RBC. PCBs were not detected in any other samples from this or other wells.

Other Organic Compounds in Groundwater

Dioxins were detected in four of the shallow grid-based monitoring wells. In accordance with recent dioxin guidance (USEPA 1995a) and Section 7 of this report, TEQs were calculated; they range from 3.29E-9 μg/l to 1.84E-7 μg/l, well below the tap-water RBC of 4.5E-4 μg/l. Calculated TEQs ranged from 1.68E-8 μg/l to 1.67E-6 μg/l for the deep groundwater samples. None of the deep grid well detections of dioxin exceeded its screening value.

Inorganic Elements in Groundwater

Twenty-three metals were detected in shallow grid-based groundwater samples. Only three – antimony, lead, and thallium – exceeded their respective screening criteria. Antimony exceeded its RBC (1.5 μg/L) in third-round samples from wells GDI002 (3.1 μg/L) and GDI003 (3.1 μg/L). Lead exceeded its RBC (15 μg/L), MCL (15 μg/L, and shallow background level (4.4 μg/L) in the second-round sample from well GDI002 (15.6 μg/L). Thallium exceeded its screening criteria in seven samples: GDI00103 (5.5 μg/L), GDI00202 (6.6 μg/L), GDI00203 (3.5 μg/L), GDI00303 (2.8 μg/L), GDI01902 (5.9 μg/L), GDI01904 (3.5 μg/L), and GDH01004 (2.7μg/L).

Twenty-one metals were detected in deep grid-based well samples. Only antimony, thallium, and manganese exceeded their respective screening criteria. Antimony was detected in sample GDI03D03 (6.1 μg/L), above the MCL of 6.0 μg/L. Thallium was detected in two samples, GDI01D02 (5.1 μg/L) and GDI02D03 (4.2 μg/L), exceeding its MCL (2 μg/L) and deep background level (2 μg/L). Thallium was not detected in any other samples. Manganese was detected in GDI00204 (261 μg/l) and GDI00302 (261 μg/L) at concentrations equal to the deep background. Manganese in the deep grid-based wells at this AOC ranged from 40.5 μg/L to 261 μg/L.

Cadmium, manganese, and zinc were detected above reference levels in the Zone H deep grid wells. Cadmium was detected in GDH10D03 at 5.3 μg/L and in GDH11D03 at 5.4 μg/L, slightly above the MCL. Manganese was detected above the deep background reference of 261 μg/L in all four rounds from GDH10D (384 μg/L to 446 μg/L) and all four rounds from GDH11D (234 μg/L to 821 μg/L).

Zinc was detected above the deep background value of 22.1 μg/Lin three samples: GDH11D03 (254 μg/L), GDH11D02 (1,180 μg/L), and GDH11D03 (62.6 μg/L).

10.10.5 Fate and Transport Assessment AOC 689 and AOC 690

AOC 689 is the unpaved marina parking area and surrounding marshlands at the southern tip of the base. The parking lot is currently in use. This site is bounded to the east by Cooper River, to the west by the dredged materials area roads, and to the south by Shipyard Creek. The marina parking area has reportedly been used for unauthorized disposal of unknown materials during filling activities. This site also has a potential point source discharge. AOC 690 is the network of roadways at the southern tip of the base, including the Lunsford Loop, a portion of Juneau Avenue, and West Road. This site extends along West Road on the boundaries between Zones I and H. The roadside areas along these gravel roads, totaling approximately 4,500 feet, are reported locations of unauthorized hazardous materials dumping by Navy ship personnel. Petroleum products are suspected materials of concern, although the history of hazardous materials dumping is largely unknown.

Environmental media sampled as part of this investigation were surface and subsurface soil. Potential constituent migration pathways evaluated for AOCs 689 and 690 include soil-to-groundwater and emission of volatiles from surface soil-to-air.

10.10.5.1 Soil-to-Groundwater Cross Media Transport

Tables 10.10.5 and 10.10.6 compare maximum detected organic and inorganic constituent concentrations, respectively, in surface and subsurface soils risk-based soil screening levels considered protective of groundwater. Maximum concentrations in soil are compared to leachability-based generic SSLs. The generic SSLs are used to provide a conservative screen, leachate entering the aquifer is assumed to be diluted by a ratio of 10:1, with no attenuation of constituents in soil (DAF=10). Soil background values for inorganics in Zone I were determined, but at the request of SCDHEC were not considered during initial comparisons of maximum soil concentrations with SSLs.

Organic Compounds

Nine organic constituents were detected in surface soil at levels exceeding their SSLs: chloromethane, methylene chloride, propionitrile, acetophenone, benzo(a)pyrene equivalents, benzo(a)anthracene, beta-BHC, delta-BHC, and dieldrin. Of these, only – beta –BHC - exceeded its SSL in subsurface soil. Figures 10.10.2 through 10.10.10 present concentrations detected at AOC 689/690 for the listed chemicals.

Methylene chloride was detected in five of 39 surface soil samples, and in one of 14 subsurface samples. Chloromethane was detected in two of 39 surface soil samples; the locations were not spatially linked. Propionitrile was detected in only one of 21 surface samples and was not coincident with other VOC detections. Acetophenone was detected in only one of 24 surface soil samples and was not spatially associated with other VOC detections. BEQs were calculated for 11 of 42 surface soil samples with six exceedances; they were calculated for only two of 14 subsurface samples with no exceedances. Benzo(a)anthracene was detected in nine of 42 surface soil samples with one exceedance, and was detected in two of 14 subsurface soil samples with no exceedances.

Table 10.10.5
Organic Chemicals Detected in Surface Soil and Subsurface Soil
Comparison to Cross-Media SSLs, Tap-Water RBCs, and Saltwater Surface Water Chronic Screening Levels
AOCs 689 and 690
Charleston Naval Complex
Charleston, South Carolina

Parameter	Maximum Concentration: Surface Soil	Maximum Concentration: Subsurface Soil	Maximum Concentration: Sediment	Maximum Concentration: Shallow GW	Screening Concentration: Soil to GW SSL	Screening Concentration: Soil to Air SSL	Screening Concentration: Tap Water RBC	Screening Concentration: Saltwater Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Volatilization Potential	Ground-water Migration Concern	Surface Water Migration Concern
Volatile Organic Compounds														
Acetone	1500	69	NA	NA	8000	1.0E+08	3700	NA	µG/KG	µG/L	NO	NO	NO	NO
Benzene c	2.9	ND	NA	NA	15	800	0.36	109	µG/KG	µG/L	NO	NO	NO	NO
2-Butanone (MEK)	ND	12	NA	NA	3900 a	NA	1900	NA	µG/KG	µG/L	NO	NO	NO	NO
Carbon disulfide	4.4	12	NA	NA	16000	720000	1000	NA	µG/KG	µG/L	NO	NO	NO	NO
Chloromethane c	60	ND	NA	NA	3.7 a	63	1.5	NA	µG/KG	µG/L	YES	NO	NO	NO
1,1-Dichloroethene c	2.3	ND	NA	NA	30	70	0.044	2240	µG/KG	µG/L	NO	NO	NO	NO
Ethylbenzene	2.2	2.3	NA	NA	6500	400000	1300	4.3	µG/KG	µG/L	NO	NO	NO	NO
Methylene chloride c	67	2.7	NA	NA	10	13000	4.1	2560	µG/KG	µG/L	YES	NO	NO	NO
Propionitrile (ethyl cyanide)	660	ND	NA	NA	440 b	NA	2.2	NA	µG/KG	µG/L	YES	NO	NO	NO
Tetrachloroethene (PCE) c	4.4	ND	NA	NA	30	11000	1.1	45	µG/KG	µG/L	NO	NO	NO	NO
Toluene	12.9	8	NA	NA	6000	650000	750	37	µG/KG	µG/L	NO	NO	NO	NO
Trichloroethene (TCE) c	14	ND	NA	NA	30	5000	1.6	NA	µG/KG	µG/L	NO	NO	NO	NO
Trichlorofluoromethane (CFC-11)	3.4	ND	NA	NA	10000 a	790000	1300	NA	µG/KG	µG/L	NO	NO	NO	NO
Xylene (total)	2.5	9.3	NA	NA	70000 a	410000	12000	NA	µG/KG	µG/L	NO	NO	NO	NO
Semivolatile Organic Compounds														
Acenaphthene	210	ND	NA	NA	290000	NA	2200	9.7	µG/KG	µG/L	NO	NO	NO	NO
Acetophenone	51	ND	NA	NA	0.12 a	NA	0.042	NA	µG/KG	µG/L	YES	NO	NO	NO
4-Aminobiphenyl c	60	ND	NA	NA	NA	NA	0.00029	NA	µG/KG	µG/L	NO	NO	NO	NO
Anthracene	340	ND	NA	NA	5900000	NA	11000	NA	µG/KG	µG/L	NO	NO	NO	NO
Benzoic acid	25000	ND	NA	NA	200000	NA	150000	NA	µG/KG	µG/L	NO	NO	NO	NO
Benzo(g,h,i)perylene	430	ND	NA	NA	1.2E+08 a	NA	1500	NA	µG/KG	µG/L	NO	NO	NO	NO
Benzo(a)pyrene Equivalents	1788	140	NA	NA	1600 a	NA	0.0092	NA	µG/KG	µG/L	YES	NO	NO	NO
Benzo(a)anthracene c	1500	110	NA	NA	800	NA	0.092	NA	µG/KG	µG/L	YES	NO	NO	NO
Benzo(a)pyrene c	1200	110	NA	NA	4000	NA	0.0092	NA	µG/KG	µG/L	NO	NO	NO	NO
Benzo(b)fluoranthene c	2400	170	NA	NA	2500	NA	0.092	NA	µG/KG	µG/L	NO	NO	NO	NO
Benzo(k)fluoranthene c	2600	190	NA	NA	25000	NA	0.92	NA	µG/KG	µG/L	NO	NO	NO	NO
Chrysene c	1600	100	NA	NA	80000	NA	9.2	NA	µG/KG	µG/L	NO	NO	NO	NO
Dibenz(a,h)anthracene c	130	ND	NA	NA	800	NA	0.0092	NA	µG/KG	µG/L	NO	NO	NO	NO
Indeno(1,2,3-cd)pyrene c	410	ND	NA	NA	7000	NA	0.092	NA	µG/KG	µG/L	NO	NO	NO	NO
Benzyl alcohol	370	ND	NA	NA	25000 a	NA	11000	NA	µG/KG	µG/L	NO	NO	NO	NO
Butylbenzylphthalate	97	ND	NA	NA	930000	930000	7300	29.4	µG/KG	µG/L	NO	NO	NO	NO
Chlorobenzilate c	45.8	ND	NA	NA	100 a	NA	0.25	NA	µG/KG	µG/L	NO	NO	NO	NO
Dibenzofuran	170	ND	NA	NA	6800 a	120000	24	NA	µG/KG	µG/L	NO	NO	NO	NO

Table 10.10.5
Organic Chemicals Detected in Surface Soil and Subsurface Soil
Comparison to Cross-Media SSLs, Tap-Water RBCs, and Saltwater Surface Water Chronic Screening Levels
AOCs 689 and 690
Charleston Naval Complex
Charleston, South Carolina

Parameter	Maximum Concentration				Screening Concentration									
	Surface Soil	Subsurface Soil	Sediment	Shallow GW	Soil to GW SSL	Soil to Air SSL	Tap Water RBC	Saltwater Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Volatilization Potential	Groundwater Migration Concern	Surface Water Migration Concern
Di-n-butylphthalate	120	140	NA	NA	2300000	2300000	3700	3.4	µG/KG	µG/L	NO	NO	NO	NO
bis(2-Ethylhexyl)phthalate (BEHP) c	1300	110	NA	NA	1800000	31000000	4.8	NA	µG/KG	µG/L	NO	NO	NO	NO
Fluoranthene	2600	87	NA	NA	2100000	NA	1500	1.6	µG/KG	µG/L	NO	NO	NO	NO
Fluorene	160	ND	NA	NA	280000	NA	1500	NA	µG/KG	µG/L	NO	NO	NO	NO
1-Methylnaphthalene	760	ND	NA	NA	72000 a	NA	1500	NA	µG/KG	µG/L	NO	NO	NO	NO
2-Methylnaphthalene	690	ND	NA	NA	230000 a	NA	1500	23.5	µG/KG	µG/L	NO	NO	NO	NO
Naphthalene	540	ND	NA	NA	42000	NA	1500	23.5	µG/KG	µG/L	NO	NO	NO	NO
Phenanthrene	1300	ND	NA	NA	660000 a	NA	1100	NA	µG/KG	µG/L	NO	NO	NO	NO
Pyrene	2200	100	NA	NA	2100000	NA	1100	NA	µG/KG	µG/L	NO	NO	NO	NO
Pesticides/PCBs														
Aldrin c	2.7	ND	NA	NA	230	3000	0.0039	0.13	µG/KG	µG/L	NO	NO	NO	NO
Aroclor-1260 c	170	73	NA	NA	1000	1000	0.033	0.03	µG/KG	µG/L	NO	NO	NO	NO
beta-BHC (beta-HCH) c	2.7	1.9	NA	NA	1.3	1E+09	0.037	NA	µG/KG	µG/L	YES	NO	NO	NO
delta-BHC (delta-HCH) c	7.4	ND	NA	NA	1.8 a	NA	0.037	NA	µG/KG	µG/L	YES	NO	NO	NO
gamma-BHC (Lindane) c	3.7	ND	NA	NA	4.5	NA	0.052	0.016	µG/KG	µG/L	NO	NO	NO	NO
Chlordane c	7.6	ND	NA	NA	5000	20000	0.19	0.004	µG/KG	µG/L	NO	NO	NO	NO
alpha-Chlordane c	2.3	ND	NA	NA	5000 b	20000	0.19	0.004	µG/KG	µG/L	NO	NO	NO	NO
gamma-Chlordane c	4	ND	NA	NA	5000 b	20000	0.19	0.004	µG/KG	µG/L	NO	NO	NO	NO
4,4'-DDD c	26	ND	NA	NA	8000	NA	0.28	0.025	µG/KG	µG/L	NO	NO	NO	NO
4,4'-DDE c	60	ND	NA	NA	27000	NA	0.2	0.14	µG/KG	µG/L	NO	NO	NO	NO
Dieldrin c	11.1	ND	NA	NA	2	1000	0.0042	0.0019	µG/KG	µG/L	YES	NO	NO	NO
Endosulfan I	33	ND	NA	NA	9000 b	NA	220	0.0087	µG/KG	µG/L	NO	NO	NO	NO
Endosulfan II	7	4.5	NA	NA	9000 b	NA	220	0.0087	µG/KG	µG/L	NO	NO	NO	NO
Endrin	5.6	ND	NA	NA	500	NA	11	0.0023	µG/KG	µG/L	NO	NO	NO	NO
Endrin aldehyde	1.9	ND	NA	NA	340 a	NA	11	NA	µG/KG	µG/L	NO	NO	NO	NO
Heptachlor c	3.1	ND	NA	NA	11000	100	0.0023	0.0036	µG/KG	µG/L	NO	NO	NO	NO
Heptachlor epoxide c	1.5	ND	NA	NA	330	5000	0.0012	0.0036	µG/KG	µG/L	NO	NO	NO	NO
Methoxychlor	75	ND	NA	NA	80000	NA	180	0.03	µG/KG	µG/L	NO	NO	NO	NO
Organophosphate Pesticides														
Methyl parathion	28	ND	NA	NA	150 a	28000	9.1	NA	µG/KG	µG/L	NO	NO	NO	NO
Herbicides														
2,4,5-T	13	ND	NA	NA	990 a	NA	370	NA	µG/KG	µG/L	NO	NO	NO	NO
Organotin														
Dibutyltin	6.66	6.65	NA	NA	NA	NA	11	NA	µG/KG	µG/L	NO	NO	NO	NO
Monobutyltin	ND	8.16	NA	NA	NA	NA	11	NA	µG/KG	µG/L	NO	NO	NO	NO
Tributyltin	ND	7.64	NA	NA	NA	NA	11	0.01	µG/KG	µG/L	NO	NO	NO	NO

Table 10.10.5
Organic Chemicals Detected in Surface Soil and Subsurface Soil
Comparison to Cross-Media SSLs, Tap-Water RBCs, and Saltwater Surface Water Chronic Screening Levels
AOCs 689 and 690
Chanleston Naval Complex
Charleston, South Carolina

Parameter	Maximum Concentration Surface Soil	Subsurface Soil	Sediment	Shallow GW	Screening Concentration Soil to GW SSL	Soil to Air SSL	Tap Water RBC	Saltwater Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Volatil-ization Potential	Ground-water Migration Concern	Surface Water Migration Concern
TPH														
Petroleum hydrocarbons, TPH	820	ND	NA	NA	NA	NA	NA	NA	µG/KG	µG/L	NO	NO	NO	NO
Dioxin Compounds														
2,3,7,8-TCDD equivalents (TEQs) c	3.9	0.349	NA	NA	1600 a	NA	0.45	10	NG/KG	PG/L	NO	NO	NO	NO
123478-HxCDD c	1.52	ND	NA	NA	4100 a	NA	4.5	NA	NG/KG	PG/L	NO	NO	NO	NO
123678-HxCDD c	2.57	ND	NA	NA	4100 a	NA	4.5	NA	NG/KG	PG/L	NO	NO	NO	NO
123789-HxCDD c	2.56	ND	NA	NA	4100 a	NA	4.5	NA	NG/KG	PG/L	NO	NO	NO	NO
1234678-HpCDD c	71.6	14.5	NA	NA	108000 a	NA	45	NA	NG/KG	PG/L	NO	NO	NO	NO
OCDD c	831	203	NA	NA	1080000 a	NA	450	NA	NG/KG	PG/L	NO	NO	NO	NO
2378-TCDF c	3.55	ND	NA	NA	200 a	NA	4.5	NA	NG/KG	PG/L	NO	NO	NO	NO
12378-PeCDF c	2.32	ND	NA	NA	800 a	NA	8.9	NA	NG/KG	PG/L	NO	NO	NO	NO
23478-PeCDF c	1.34	ND	NA	NA	100 a	NA	0.89	NA	NG/KG	PG/L	NO	NO	NO	NO
123478-HxCDF c	2.95	0.748	NA	NA	216000 a	NA	4.5	NA	NG/KG	PG/L	NO	NO	NO	NO
123678-HxCDF c	3.01	ND	NA	NA	216000 a	NA	4.5	NA	NG/KG	PG/L	NO	NO	NO	NO
123789-HxCDF c	0.656	0.338	NA	NA	216000 a	NA	4.5	NA	NG/KG	PG/L	NO	NO	NO	NO
234678-HxCDF c	1.19	ND	NA	NA	216000 a	NA	4.5	NA	NG/KG	PG/L	NO	NO	NO	NO
1234678-HpCDF c	16.7	5.06	NA	NA	54000 a	NA	45	NA	NG/KG	PG/L	NO	NO	NO	NO
OCDF c	26.3	8.68	NA	NA	540000 a	NA	450	NA	NG/KG	PG/L	NO	NO	NO	NO

Notes:
Sources of screening concentrations appear in Table 5.5
Explanations of fate and transport screening procedures appear in Section 6.2.
Frequency and range of detections, average detected concentrations, and number of screening concentration exceedances appear in Table 10.10.2

a - Calculated soil to groundwater SSL value (See Table 6.2)
b - Based on surrogate compound; see Table 5.5
c - Carcinogenic
GW - Groundwater

NA - Not applicable/not available
ND - Not detected
RBC - Risk-based concentration
SSL - Soil screening level

NG/KG - Nanograms per kilogram
µG/KG - Micrograms per kilogram
PG/L - Picograms per liter
µG/L - Micrograms per liter

Table 10.10.6
Inorganic Chemicals Detected in Surface Soil, Subsurface Soil, Sediment, and Shallow Groundwater
Comparison to Cross-media SSLs, Tap-Water RBCs, Saltwater Surface Water Chronic Screening Levels, and Background Values
AOCs 689 and 690
Charleston Naval Complex
Charleston, South Carolina

Parameter	Maximum Concentration Surface Soil	Subsurface Soil	Sediment	Shallow GW	Screening Concentration Soil to GW SSL	Soil Backgroun	Soil to Air SSL	Tap Water RBC	Shallow GW Background	Saltwater Surf. Wtr Chronic	Soil Units	Water Units	Leaching Potential	Fugitive Particulate Inhalation Concern	Ground-water Migration Concern	Surface Water Migration Concern
Inorganic Chemicals																
Aluminum (Al)	22400	22500	NA	NA	560000 a	27400	NA	37000	1440	NA	MG/KG	µG/L	NO	NO	NO	NO
Antimony (Sb)	24.5	ND	NA	NA	2.7	ND	NA	15	NA	NA	MG/KG	µG/L	YES	NO	NO	NO
Arsenic (As) c	28.7	13	NA	NA	15	21.6	750	0.045	23	36	MG/KG	µG/L	YES	NO	NO	NO
Barium (Ba)	203	33.6	NA	NA	820	54.2	690000	2600	110	NA	MG/KG	µG/L	NO	NO	NO	NO
Beryllium (Be)	1	1.8	NA	NA	32	0.95	1300	73	1.1	NA	MG/KG	µG/L	NO	NO	NO	NO
Cadmium (Cd)	1	0.61	NA	NA	4	0.61	1800	18	NA	9.3	MG/KG	µG/L	NO	NO	NO	NO
Chromium (Cr) (total)	132	51.7	NA	NA	19	51.3	270	180	14.3	50	MG/KG	µG/L	YES	NO	NO	NO
Chromium (Cr6) (hexavalent)	3.98	NA	NA	NA	19	ND	270	180	ND	50	MG/KG	µG/L	NO	NO	NO	NO
Cobalt (Co)	4.6	5.5	NA	NA	990 a	5.8	NA	2200	2.2	NA	MG/KG	µG/L	NO	NO	NO	NO
Copper (Cu)	321	30.2	NA	NA	5600 a	240	NA	1500	4.4	2.9	MG/KG	µG/L	NO	NO	NO	NO
Lead (Pb)	173	43.3	NA	NA	400	203	400	15	4.4	8.5	MG/KG	µG/L	NO	NO	NO	NO
Manganese (Mn)	461	400	NA	NA	480 a	419	NA	730	5430	NA	MG/KG	µG/L	NO	NO	NO	NO
Mercury (Hg)	0.67	0.2	NA	NA	1	0.47	10	11	NA	0.025	MG/KG	µG/L	NO	NO	NO	NO
Nickel (Ni)	62.3	28	NA	NA	65	23.9	13000	730	13.3	8.3	MG/KG	µG/L	NO	NO	NO	NO
Selenium (Se)	1.6	1.4	NA	NA	2.6	1.77	NA	180	ND	71	MG/KG	µG/L	NO	NO	NO	NO
Tin (Sn)	14.6	1.3	NA	NA	5500 a	7.5	NA	22000	NA	NA	MG/KG	µG/L	NO	NO	NO	NO
Vanadium (V)	47.7	53.3	NA	NA	3000	113	NA	260	14	NA	MG/KG	µG/L	NO	NO	NO	NO
Zinc (Zn)	319	78.2	NA	NA	6200	206	NA	11000	24.4	86	MG/KG	µG/L	NO	NO	NO	NO

Notes:
Sources of screening concentrations appear in Table 5.6
Explanations of fate and transport screening procedures appear in Section 6.2.
Frequency and range of detections, average detected concentrations, and number of screening concentration exceedances appear in Table 10.10.3.

Background values for soil are shown for comparison purposes only.
Maximum groundwater concentrations are screened against the greater of tap-water RBCs or corresponding background values to determine groundwater migration concern.

a - Calculated soil to groundwater SSL value (See Table 6.2)
c - Carcinogenic
GW - Groundwater

NA - Not available/Not applicable
ND - Not detected
RBC - Risk-based concentration

SSL - Soil screening level
MG/KG - Milligrams per kilogram
µG/L - Micrograms per liter

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

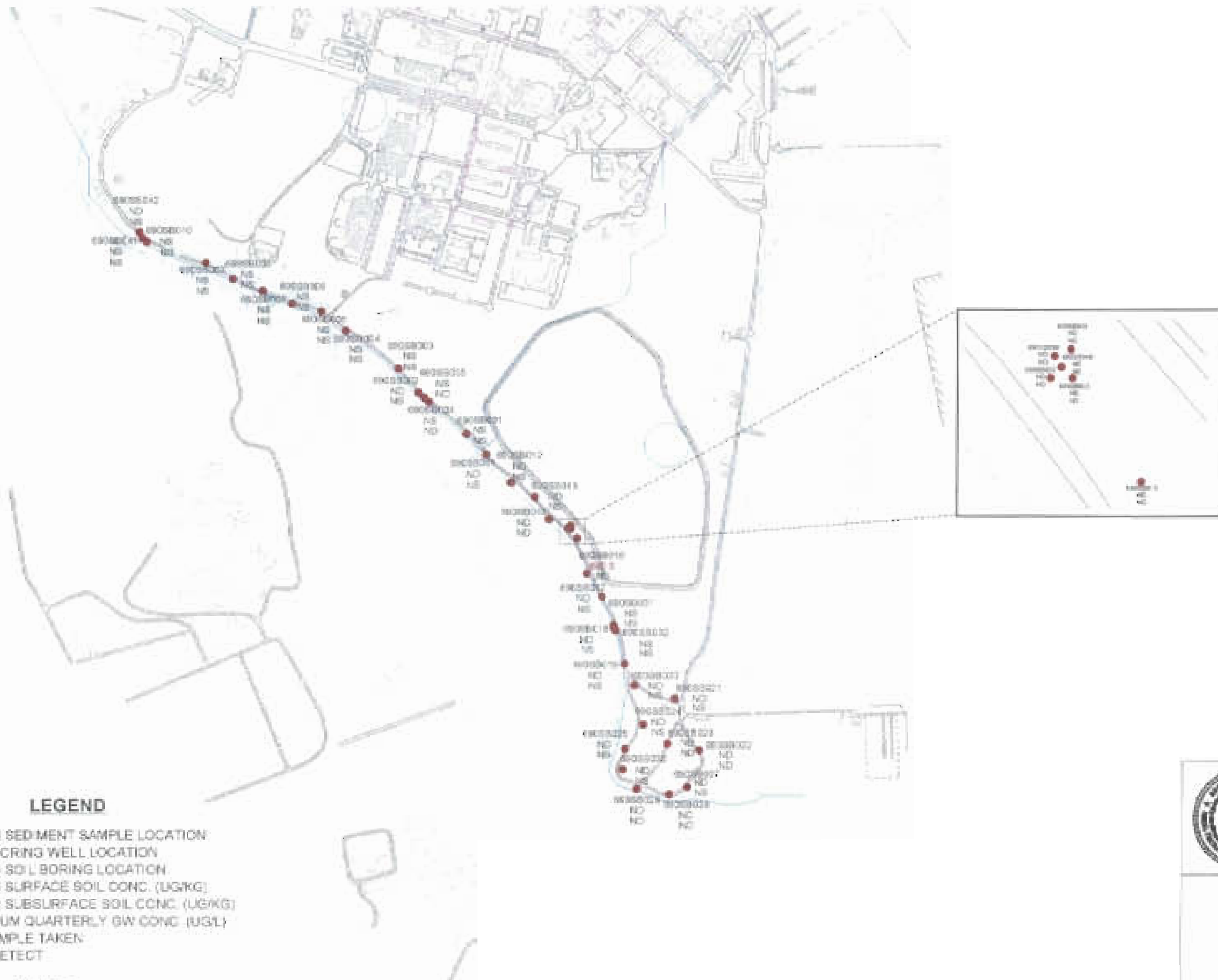
FIGURE 10.10.2
ZONE I
AOC 689/690
CHLOROMETHANE
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL= NA RBC=49000 UG/KG SSL=3.7 UG/KG

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.10.3
ZONE I
AOC 689/690
METHYLENE CHLORIDE
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL= NA RBC=85000 UG/KG SSL=10 UG/KG



N

LEGEND

- ZONE I SEDIMENT SAMPLE LOCATION
- MONITORING WELL LOCATION
- ZONE I SOIL BORING LOCATION
- 12.30 ZONE I SURFACE SOIL CONC. (UG/KG)
- 12.30 ZONE I SUBSURFACE SOIL CONC. (UG/KG)
- 12.30 MAXIMUM QUARTERLY GW CONC. (UG/L)
- NS NO SAMPLE TAKEN
- ND NON DETECT

SCALE

20 0 20 40 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.10.4
ZONE I
AOC 689/690
PROPIONITRILE
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL= NA RBC=47000 UG/KG SSL=440 UG/KG

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.10.5
ZONE I
AOC 689/690
ACETOPHENONE
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL= NA RBC=780000 UG/KG SSL=.12 UG/KG

LEGEND

- ZONE I SEDIMENT SAMPLE LOCATION
- MONITORING WELL LOCATION
- ZONE I SOIL BORING LOCATION
- 12.30 ZONE I SURFACE SOIL CONC. (UG/KG)
- 12.30 ZONE I SUBSURFACE SOIL CONC. (UG/KG)
- 12.30 MAXIMUM QUARTERLY GW CONC. (UG/L)
- NS NO SAMPLE TAKEN
- ND NON DETECT

SCALE

20 0 20 40 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.10.5
ZONE I
AOC 689/690
BEQs
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL= .2 UG/L RBC=87 UG/KG SSL=1600 UG/KG

N

LEGEND

- ZONE I SEDIMENT SAMPLE LOCATION
- MONITORING WELL LOCATION
- ZONE I SOIL BORING LOCATION

12.30 ZONE I SURFACE SOIL CONC. (UG/KG)
12.30 ZONE I SUBSURFACE SOIL CONC. (UG/KG)
12.30 MAXIMUM QUARTERLY GW CONC. (UG/L)
NS NO SAMPLE TAKEN
ND NON DETECT

SCALE

20 0 20 40 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.10.7
ZONE I
AOC 689/690
BENZO(A)ANTHRACENE
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL= NA RBC=870 UG/KG SSL=800 UG/KG

LEGEND

- ZONE I SEDIMENT SAMPLE LOCATION
- MONITORING WELL LOCATION
- ZONE I SOIL BORING LOCATION

12.30 ZONE I SURFACE SOIL CONC. (UG/KG)
12.30 ZONE I SUBSURFACE SOIL CONC. (UG/KG)
12.30 MAXIMUM QUARTERLY GW CONC. (UG/L)
NS NO SAMPLE TAKEN
NC NON DETECT

SCALE
20 0 20 40 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.10.8
ZONE I
AOC 689/690
BETA-BHC
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL= NA RBC=350 UG/KG SSL=1.3 UG/KG

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.10.9
ZONE I
AOC 689/690
DELTA-BHC
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL= NA RBC=350 UG/KG SSL=1.8 UG/KG

LEGEND

- ZONE I SEDIMENT SAMPLE LOCATION
- MONITORING WELL LOCATION
- ZONE I SOIL BORING LOCATION
- 12.30 ZONE I SURFACE SOIL CONC. (UG/KG)
- 12.30 ZONE I SUBSURFACE SOIL CONC. (UG/KG)
- 12.30 MAXIMUM QUARTERLY GW CONC. (UG/L)
- NS NO SAMPLE TAKEN
- ND NON DETECT

SCALE

20 0 20 40 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.10.10
ZONE I
AOC 689/690
DIELDRIN
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL= NA RBC=40 UG/KG SSL=2 UG/KG

Beta-BHC was detected in three of 30 surface soil samples; with all three exceeded the SSL. Beta-BHC was detected in one of seven subsurface soil samples, at a level above its SSL. Detections of beta-BHC were repeated vertically between surface and subsurface soil at concentrations above SSL, at only one location (690SB015). Delta-BHC was detected in two of 30 surface samples, but was non-detect in subsurface samples. Delta-BHC and beta-BHC detections were not spatially correlative. Dieldrin was detected in only one of 30 surface soil samples not spatially correlative to the other pesticide detections was nondetect in subsurface samples.

The presence of organics in surface soil is not unexpected based on past site activities. None of the detections exhibit significant magnitude or frequency. All but the beta-BHC were either non-detect or below their SSLs in subsurface soil. Thus, the soil-to-groundwater pathway for organics is valid only for beta-BHC. Since the subsurface concentration of beta-BHC is not significantly above its SSL, the pathway, although valid, is not expected to be greatly significant.

Inorganic Compounds

Three inorganic constituents: antimony, arsenic, and chromium were detected in surface soil at levels exceeding their SSLs. Of these, only chromium exceeded its SSL in subsurface soil samples.

Antimony was detected in four of 39 surface soil samples, with one detection above its SSL, and was nondetect in subsurface soil. Figure 10.10.11 presents antimony concentrations detected at AOC 689/690. Arsenic was widely detected, but exceeded its SSL in only one surface soil sample. Figure 10.10.12 presents arsenic concentrations detected. Chromium was also widely detected, with 13 samples above background in surface soil but only one above background in subsurface samples. Figure 10.10.13 presents chromium concentrations detected. The majority of chromium detections were above the calculated SSL.

Antimony has been detected sporadically in Zone I soil, and its presence is not conclusively related to past site activities. Since antimony is nondetect in subsurface soil, the soil-to-groundwater pathway is effectively invalidated for this constituent. Both arsenic and chromium have been detected widely in zone-wide soil and their presence at AOC 689/690 may reflect this zone-wide occurrence rather than specific site activities. The absence of arsenic in subsurface soil above its SSL invalidates the soil-to-groundwater pathway for this constituent. The pathway for chromium may be valid; however, since most chromium detections are consistent with the range of background concentrations, analysis of chromium exceedances should be weighed carefully.

10.10.5.2 AOCs 689 and 690 Soil-to-Air Transport

While 13 VOCs were detected in surface soil, all concentrations were far below their soil-to-air SSLs. Therefore, the pathway is not expected to be significant at this site.

10.10.5.3 Fate and Transport Summary

Soil-to-Groundwater Pathway

Nine organic constituents were detected in surface soil at levels exceeding their SSLs: methylene chloride, chloromethane, propionitrile, acetophenone, benzo(a)pyrene equivalents, benzo(a)anthracene), beta-BHC, delta-BHC, and dieldrin.

- Only beta-BHC exceeded its SSL in the subsurface, and only at one location.

- The presence of organics may be associated with past site activities, but none of the detections exhibit significant magnitude or frequency.

- The pathway is valid for beta-BHC only. The limited mass above the SSL and the relatively low concentration lessen the significance of the pathway.

LEGEND

- ZONE I SEDIMENT SAMPLE LOCATION
- MONITORING WELL LOCATION
- ZONE I SOIL BORING LOCATION

12.30 ZONE I SURFACE SOIL CONC. (MG/KG)
12.30 ZONE I SUBSURFACE SOIL CONC. (MG/KG)
12.30 MAXIMUM QUARTERLY GW CONC. (UG/L)
NS NO SAMPLE TAKEN
ND NON DETECT

SCALE

20 0 20 40 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.10.11
ZONE I
AOC 689/690
ANTIMONY
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL= 6 UG/L RBC=3.1 MG/KG SSL=2.7 MG/KG

LEGEND

- ZONE I SEDIMENT SAMPLE LOCATION
- ■ MONITORING WELL LOCATION
- ZONE I SOIL BORING LOCATION
- 12.30 ZONE I SURFACE SOIL CONC. (MG/KG)
- 12.30 ZONE I SUBSURFACE SOIL CONC. (MG/KG)
- 12.30 MAXIMUM QUARTERLY GW CONC. (UG/L)
- NS NO SAMPLE TAKEN
- ND NON DETECT

SCALE

20 0 20 40 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.10.12
ZONE I
AOC 689/690
ARSENIC
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL= 50 UG/L RBC=.43 MG/KG SSL=15 MG/KG

LEGEND

- ● ZONE I SEDIMENT SAMPLE LOCATION
- ■ MONITORING WELL LOCATION
- ● ZONE I SOIL BORING LOCATION
- 12.30 ZONE I SURFACE SOIL CONC. (MG/KG)
- 12.30 ZONE I SUBSURFACE SOIL CONC. (MG/KG)
- 12.30 MAXIMUM QUARTERLY GW CONC. (UG/L)
- NS NO SAMPLE TAKEN
- ND NON DETECT

SCALE

20 0 20 40 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON SC

FIGURE 10.10.13
ZONE I
AOC 689/690
CHROMIUM
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL= 100 UG/L RBC=39 MG/KG SSL=19 MG/KG

Three inorganic constituents were detected in surface soil samples at levels exceeding their SSL antimony, arsenic, and chromium.

- Only chromium exceeded its SSL in subsurface samples.

- From a strict chemical standpoint, the pathway for chromium is valid. However, the majority of chromium detections are consistent with the range expected under background conditions, which lessens the significance of the pathway.

Soil-to-Air Pathway

Three organics were detected in surface soil, but none exceeded the soil-to-air SSL, thus, this pathway is not expected to be significant.

10.10.6 Human Health Risk Assessment

10.10.6.1 Site Background and Investigative Approach

The purpose of the investigation at AOCs 689 and 690 was the assessment of soil potentially affected by past site activities. AOC 689 is the unpaved marina parking area, a reported site of unauthorized disposal of unknown materials during filling activities. AOC 690 is the network of roadways at the southern tip of the base, including the Lunsford Loop, a portion of Juneau Avenue, and West Road. This site extends along West Road on the boundaries between Zones I and H. The roadside areas along these gravel roads, totaling approximately 4,500 feet, are reported locations of unauthorized hazardous materials dumping by Navy ship personnel.

Soil was sampled in four rounds at AOCs 689 and 690 at the locations shown on Figure 10.10.1. Ten of the 20 proposed upper-interval soil samples were collected in the first-round and analyzed for the standard suite (VOCs, SOVCs, metals, cyanide, pesticides, and PCBs) and TPH at DQO Level III. The first-round sampling occurred concurrently with the field investigation for Zone H to determine the potential impacts of Zone H to AOC 690. Twenty upper-interval samples and seven of the 20 proposed lower-interval samples were collected in the second-round. Second-round samples were submitted for the standard suite and organotins and dioxins at DQO Level III. One duplicate was submitted in round one for Appendix IX and TPH analyses at DQO Level IV and two were submitted in round two for Appendix IX and analyses only at DQO Level IV. Third-round sampling was performed following a comparison of first and second-round analytical results to RBCs and SSLs. Three upper-interval soil samples were collected and analyzed for SVOCs. Nine fourth-round upper-interval soil samples were collected and analyzed for VOCs, SVOCs, and metals at DQO Level III. Seven lower-interval soil samples were collected and analyzed for VOCs, SVOCs and metals. One duplicate was submitted in round four for VOCs, SVOCs and metals.

10.10.6.2 COPC Identification

Soil

Based on the screening comparisons described in Section 7 of this RFI and presented in Table 10.10.7, the focus of this HHRA is on the following COPCs: benzo(a)pyrene equivalents, antimony, arsenic, chromium, copper, manganese, and 4-aminobiphenyl. Wilcoxon rank sum test analyses did not result in the inclusion of any inorganic constituent that had been screened out on the basis of background concentrations.

10.10.6.3 Exposure Assessment

Exposure Setting

AOC 689 is the unpaved marina parking area located at the southern tip of the base. AOC 690 includes the Dredged Materials Area roads. The combined AOC site is principally a long narrow strip of land which borders the west side of the Dredged Materials Area (DMA). Both AOCs were reportedly used for unauthorized disposal activities. The future use of this combined AOC

Table 10.10.7
Chemicals Present in Site Samples
AOCs 689 and 690 - Surface Soil
Charleston Naval Complex
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration Residential RBC	Background	Units	Number Exceeding RBC	Background
Carcinogenic PAHs													
Benzo(a)pyrene Equivalents	*	17	41	0.39	1790	278	487	48900	87	NA	µG/KG	7	
Benzo(a)anthracene	*	9	41	46	1500	428	370	3600	870	NA	µG/KG	1	
Benzo(a)pyrene	*	11	41	47	1200	296	333	3600	87	NA	µG/KG	6	
Benzo(b)fluoranthene	*	16	41	41.2	2400	416	370	3600	870	NA	µG/KG	2	
Benzo(k)fluoranthene		15	41	39	2600	430	333	3600	8700	NA	µG/KG		
Chrysene		13	41	46	1600	363	370	3600	87000	NA	µG/KG		
Dibenz(a,h)anthracene	*	3	41	28	130	92.7	333	3600	87	NA	µG/KG	2	
Indeno(1,2,3-cd)pyrene		3	41	90	410	253	333	3600	870	NA	µG/KG		
Inorganics													
Aluminum (Al)		39	39	920	22400	7550	NA	NA	7800	27400	MG/KG	14	
Antimony (Sb)	*	4	39	0.28	24.5	6.45	0.2	8.5	3.1	ND	MG/KG	1	
Arsenic (As)	*	37	39	1.3	28.7	7	0.37	23.1	0.43	21.6	MG/KG	37	2
Barium (Ba)		30	39	5.6	203	28.2	7	27.8	550	54.2	MG/KG		1
Beryllium (Be)		8	39	0.39	1	0.63	0.05	0.86	16	0.95	MG/KG		1
Cadmium (Cd)		11	39	0.07	1	0.58	0.04	1.1	7.8	0.61	MG/KG		4
Calcium (Ca)	N	39	39	4870	337000	93000	NA	NA	NA	NA	MG/KG		
Chromium (Cr)	*	39	39	4.1	132	33.2	NA	NA	39	34.5	MG/KG	11	13
Chromium (Cr) (Hexavalent)		2	3	0.51	3.98	2.25	0.01	0.01	39	ND	MG/KG		
Cobalt (Co)		25	39	0.32	4.6	2.70	1.1	3.8	470	5.8	MG/KG		
Copper (Cu)	*	35	39	0.72	321	47.8	4.3	14.5	310	240	MG/KG	1	2
Iron (Fe)	N	39	39	775	22700	7780	NA	NA	NA	NA	MG/KG		
Lead (Pb)		38	39	2.8	173	38.1	2.5	2.5	400	203	MG/KG		
Magnesium (Mg)	N	39	39	144	5680	2760	NA	NA	NA	NA	MG/KG		
Manganese (Mn)	*	39	39	8.7	461	129	NA	NA	160	419	MG/KG	11	1
Mercury (Hg)		25	39	0.02	0.67	0.16	0.03	0.14	2.3	0.47	MG/KG		2
Nickel (Ni)		35	39	0.56	62.3	14	3.8	12.8	160	23.9	MG/KG		3
Potassium (K)	N	35	39	167	2340	1010	395	501	NA	NA	MG/KG		
Selenium (Se)		29	39	0.11	1.6	0.75	0.36	0.61	39	1.49	MG/KG		1
Sodium (Na)	N	22	39	30.2	2300	620	155	876	NA	NA	MG/KG		
Tin (Sn)		10	39	0.96	14.6	5.92	0.43	2	4700	7.5	MG/KG		4
Vanadium (V)		36	39	3.4	47.7	20.2	4.4	7.7	55	113	MG/KG		
Zinc (Zn)		37	39	2.6	319	72.6	20.2	22	2300	206	MG/KG		2

Table 10.10.7
Chemicals Present in Site Samples
AOCs 689 and 690 - Surface Soil
Charleston Naval Complex
Charleston, South Carolina

Parameter	Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration Residential RBC	Screening Concentration Background	Units	Number Exceeding RBC	Number Exceeding Background
Organotin												
Dibutyltin	1	20	6.66	6.66	6.66	3	4.3	2300	NA	µG/KG		
Pesticides/PCBs												
4,4'-DDD	3	30	3.7	26	14.6	3.9	9	2700	NA	µG/KG		
4,4'-DDE	9	30	2.4	60	16.8	3.9	4.8	1900	NA	µG/KG		
Aldrin	2	30	1.9	2.7	2.3	1.1	4	38	NA	µG/KG		
alpha-Chlordane	1	10	2.3	2.3	2.3	4	4	1800	NA	µG/KG		
Aroclor-1260	6	30	39	170	90.7	22	40	320	NA	µG/KG		
beta-BHC	3	30	1.5	2.7	2	1.1	4	350	NA	µG/KG		
Chlordane	1	20	7.6	7.6	7.6	4.3	5.6	1800	NA	µG/KG		
delta-BHC	2	30	2.3	7.4	4.85	1.1	4	350	NA	µG/KG		
Dieldrin	1	29	11.1	11.1	11.1	1.6	4	40	NA	µG/KG		
Endosulfan I	4	30	2	33	10.4	1.6	4	47000	NA	µG/KG		
Endosulfan II	2	30	6.1	7	6.55	3.9	9	47000	NA	µG/KG		
Endrin	1	30	5.6	5.6	5.6	2.7	4.5	2300	NA	µG/KG		
Endrin aldehyde	2	30	1.2	1.9	1.55	1.1	9	2300	NA	µG/KG		
gamma-BHC (Lindane)	2	30	1.2	3.7	2.45	1.1	4	490	NA	µG/KG		
gamma-Chlordane	1	10	4	4	4	4	4	1800	NA	µG/KG		
Heptachlor	3	30	1.2	3.1	2.13	1.1	4	140	NA	µG/KG		
Heptachlor epoxide	2	30	1.4	1.5	1.45	1.1	4	70	NA	µG/KG		
Methoxychlor	3	30	2.8	75	28.1	3.9	40	39000	NA	µG/KG		
Herbicide												
2,4,5-T	2	2	6.3	13	9.65	NA	NA	78000	NA	µG/KG		
Semivolatile Organics												
1-Methyl naphthalene	7	22	47	760	216	1200	1500	310000	NA	µG/KG		
2-Methylnaphthalene	7	41	39	690	221	370	3600	310000	NA	µG/KG		
4-Aminobiphenyl *	1	23	60	60	60	333	570	2.8	NA	µG/KG	1	
Acenaphthene	1	41	210	210	210	333	3600	470000	NA	µG/KG		
Acetophenone	1	23	51	51	51	333	920	780000	NA	µG/KG		
Anthracene	4	41	17	340	130	333	3600	2300000	NA	µG/KG		
Benzo(g,h,i)perylene	3	41	85	430	252	333	3600	310000	NA	µG/KG		
Benzoic acid	1	39	25000	25000	25000	1900	2600	31000000	NA	µG/KG		
Benzyl alcohol	1	41	370	370	370	333	3600	2300000	NA	µG/KG		

Table 10.10.7
Chemicals Present in Site Samples
AOCs 689 and 690 - Surface Soil
Charleston Naval Complex
Charleston, South Carolina

Parameter	Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration Residential RBC	Screening Concentration Background	Units	Number Exceeding RBC	Number Exceeding Background
bis(2-Ethylhexyl)phthalate (BEHP)	11	41	44	1300	337	333	3600	46000	NA	µG/KG		
Butylbenzylphthalate	1	41	97	97	97	333	3600	1600000	NA	µG/KG		
Chlorobenzilate	1	23	45.8	45.8	45.8	730	990	2400	NA	µG/KG		
Dibenzofuran	5	41	20	170	80.6	370	3600	31000	NA	µG/KG		
Di-n-butylphthalate	13	41	41	120	61.9	333	3600	780000	NA	µG/KG		
Fluoranthene	18	41	18	2600	427	370	3600	310000	NA	µG/KG		
Fluorene	1	41	160	160	160	333	3600	310000	NA	µG/KG		
Naphthalene	5	41	72	540	214	370	3600	310000	NA	µG/KG		
Phenanthrene	11	41	12	1300	364	370	3600	230000	NA	µG/KG		
Pyrene	17	41	15	2200	371	370	3600	230000	NA	µG/KG		
Volatile Organics												
1,1-Dichloroethene	1	39	2.3	2.3	2.3	5.6	810	1100	NA	µG/KG		
Acetone	7	39	38	1500	378	10	6800	780000	NA	µG/KG		
Benzene	1	38	2.9	2.9	2.9	5	810	22000	NA	µG/KG		
Carbon disulfide	1	39	4.4	4.4	4.4	5.6	810	780000	NA	µG/KG		
Chloromethane	2	39	24.7	60	42.4	11	1600	49000	NA	µG/KG		
Ethylbenzene	1	39	2.2	2.2	2.2	5	810	780000	NA	µG/KG		
Methylene chloride	5	39	2	67	29.4	5.6	1600	85000	NA	µG/KG		
Propionitrile	1	15	660	660	660	10	820	47000	NA	µG/KG		
Tetrachloroethene	1	39	4.4	4.4	4.4	5	810	12000	NA	µG/KG		
Toluene	10	39	2	12.9	4.92	5.6	810	1600000	NA	µG/KG		
Trichloroethene	4	38	3.7	14	7.68	5	810	58000	NA	µG/KG		
Trichlorofluoromethane	1	30	3.4	3.4	3.4	6	810	2300000	NA	µG/KG		
Xylene (Total)	1	39	2.5	2.5	2.5	5	810	16000000	NA	µG/KG		
Organophosphate Pesticide												
Methyl parathion	1	3	28	28	28	8.2	33	2000	NA	µG/KG		
TPH												
Petroleum Hydrocarbons, TPH	2	10	140	820	480	65	79	NA	NA	µG/KG		

Table 10.10.7
Chemicals Present in Site Samples
AOCs 689 and 690 - Surface Soil
Charleston Naval Complex
Charleston, South Carolina

Parameter	Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration Residential RBC	Screening Concentration Background	Units	Number Exceeding RBC	Number Exceeding Background
TCDD Equivalents												
Dioxin (TCDD Equivalents)	21	21	0.044	3.9	0.69	0.43	2.02	4.3	NA	NG/KG		

Notes:
* - Indicates chemical was identified as a COPC
N - Indicates chemical is an essential nutrient
SQL - Sample quantitation limit
RBC - Risk-based concentration
µG/KG - micrograms per kilogram
MG/KG - milligrams per kilogram
NG/KG - nanograms per kilogram
NA - Not applicable or not available
ND - Not determined due to lack of information

cannot be definitively stated. Current base reuse plans indicate that the area is slated for use as an open buffer space. Groundwater is not currently used as potable or process water, nor is such use anticipated.

Potentially Exposed Populations

Potentially exposed populations are current and future site workers, hypothetical future site residents, and adolescent trespassers. Future site resident and worker exposure scenarios were addressed quantitatively in this risk assessment. The future site resident scenario was built on the premise that existing features would be removed and replaced with dwellings. The resident child scenario was considered to be conservatively representative of the adolescent trespasser.

The future site worker scenario assumed continuous exposure to surface soils. Exposure for current site workers would be less than this because of their limited soil contact. Therefore, the future worker scenario is considered to be conservatively representative of current site workers exposure.

Exposure Pathways

Exposure pathways for the hypothetical future site residents are dermal contact and incidental ingestion of surface soil. The exposure pathways for future site workers are the same. In addition, the future site worker scenario assumed continuous exposure to surface soil. Uniform exposure was assumed for all sample locations. Table 10.10.8 presents the justification for assessing exposure pathways particular in this HHRA.

Exposure Point Concentrations

Table 10.10.9 presents the UCLs calculated for each surface soil COPC. As discussed in Section 7 of this RFI, UCLs were calculated for datasets consisting of least 10 samples. The 95%

Table 10.10.8
AOCs 689 and 690
Exposure Pathways Summary

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Current Land Uses			
Current Users (Site Workers)	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	This exposure pathway was considered insignificant compared to the other pathways.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Shallow groundwater is not currently used as a source of potable or non-residential water at AOCs 689/690.
	Shallow groundwater, Inhalation of volatilized shallow groundwater contaminants	No	Shallow groundwater is not currently used as a source of potable or non-residential water at AOCs 689/690.
	Soil, Incidental ingestion	No (Qualified)	Future site use is considered conservatively representative of current receptors.
	Soil, Dermal contact	No (Qualified)	Future site use is considered conservatively representative of current receptors.
Future Land Uses			
Future Site Residents (Child and Adult), Future Site Workers	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	This exposure pathway was considered insignificant compared to the other pathways.
	Shallow groundwater, ingestion of contaminants during potable or general use	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Shallow groundwater, Inhalation of volatilized contaminants during domestic use	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Soil, Incidental ingestion	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.
	Soil, Dermal contact	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.
	Wild game or domestic animals, Ingestion of tissue impacted by media contamination	No	Hunting/taking of game and/or raising livestock is prohibited within the Charleston, South Carolina city limits.
	Fruits and vegetables, Ingestion of plant tissues grown in media	No	The potential for significant exposure via this pathway is low relative to that of other exposure pathways assessed.

Table 10.10.9
Statistical Analysis of COPCs
Surface Soils at AOCs 689 and 690
Charleston Naval Complex
Charleston, South Carolina

COPC	n	Natural Log Transformed mean	SD	H-stat	UCL (mg/kg)	MAX (mg/kg)	EPC (mg/kg)	
Benzo(a)pyrene Equivalents	41	-0.490	0.474	1.885	0.79	1.79	0.79	UCL
Arsenic	39	1.491	1.060	2.448	11.9	28.7	11.9	UCL
Chromium	39	3.227	0.759	2.127	43.7	132	43.7	UCL
Copper	39	3.046	1.232	2.653	76.4	321	76.4	UCL
Manganese	39	4.571	0.849	2.217	188	461	188	UCL
4-Aminobiphenyl	23	-1.471	0.317	1.837	0.27	0.06	0.06	MAX
Antimony	39	0.122	1.250	2.675	4.25	24.5	4.25	UCL

Notes:
mean = arithmetic mean of the logtransformed data
n = number of samples analyzed
SD = standard deviation for a sample of data
H-stat = "H" statistic from Gilbert 1987; cuboidal interpolation was used to determine the value in accordance with *USEPA Supplemental Guidance to RAGS*, Calculating the Concentration Term.
EPC = exposure point concentration
UCL = 95 percentile upper confidence level mean
MAX = maximum reported concentration

UCLs calculated for benzo(a)pyrene equivalents, antimony, arsenic, chromium, copper, and manganese were applied as their EPCs. For 4-aminobiphenyl, the maximum reported concentration was exceeded by its 95% UCL; and as a result, the maximum reported concentration was applied as its EPCs.

Benzo(a)pyrene equivalents were detected in 17 of 41 surface soil samples, including six detections (690SB007, 690SB010, 690SB18, 690SB029, 690SB031, 690SB032, and 690SB042) at concentrations exceeding the residential RBC. An FI/FC factor was derived to account for the limited areal extent of the BEQs at levels of concern. This factor was conservatively estimated to be 0.5, based upon frequency of detection and the approximate size of the impacted area relative to the entire site. This FI/FC factor indicates that the concentrations reported at 690SB018 represent soil quality over 50 percent of the potential exposure area. This factor was used to adjust the EPC for BEQs.

A similar approach was used for 4-aminobiphenyl, which was detected in only one of 23 surface soil samples (690SB020) at a concentration above the residential RBC. The EPC for 4-aminobiphenyl was established as the maximum detected (0.060 mg/kg at location 690SB020). The FI/FC factor was conservatively estimated to be 0.1, based upon frequency of detection, and this factor was used to adjust the EPC for 4-aminobiphenyl.

The FI/FCs for benzo(a)pyrene equivalents and 4-aminobiphenyl were applied to account for the scattered nature of detections above the respective residential RBCs over the area of investigation. In no instance were both compounds present at a single location in excess of their RBCs. These results support the premise that materials may have been discarded in a haphazard manner along the of Least Tern and West Roads. It is possible that an individual (worker or resident) could be periodically exposed to soil in a finite area with concentrations in excess of the FI/FC adjusted EPCs. However, the hot-spot approach was considered a more reasonable approximation of true chronic exposure potential, and did not exclude any COPC from consideration based on lack of spatial correlation.

Quantification of Exposure

CDIs for ingestion and dermal contact with soils are shown in Tables 10.10.10 and 10.10.11, respectively.

10.10.6.4 Toxicity Assessment

Toxicity assessment terms and methods are discussed in Section 7 of this report. Table 10.10.12 presents toxicological information specific to each COPC identified at AOC 689/690. This information was used in the quantification of risk/hazard associated with soil contaminants. Brief toxicological profiles for each COPC are provided in the following paragraphs.

Benzidine (surrogate for 4-aminobiphenyl) can cause bladder irritation in humans, brain cell vacuolizations, and liver cell alterations in female mice. The oral RfD for benzidine is 3E-03 mg/kg-day with an uncertainty factor of 1,000. Benzidine has been classified by USEPA's weight-of-evidence as group "A," human carcinogen, based on observation of increased incidence of bladder cancer and related deaths in exposed workers. The oral SF for benzidine is 2.3E+02 mg/kg-day, and the inhalation SF is 6.7E-02.

Antimony is absorbed slowly through the gastrointestinal tract, which is the target of this element. Another target is the blood, where antimony concentrates. Antimony is used frequently in industry, and primary exposure route to the general population is ingestion. Antimony is also a common air pollutant from industrial emissions. USEPA has not classified antimony as a carcinogen, and the oral RfD is 0.0004 mg/kg-day (Klaasen, et al., 1986). The oral RfD is based on a LOAEL of 0.35 mg/kg-day, an uncertainty factor of 1,000, and a modifying factor of 1.

Table 10.10.10
Chronic Daily Intakes
Incidental Ingestion of Surface Soil
AOCs 689 and 690
Charleston Naval Complex
Charleston, South Carolina

Chemical	Fraction Ingested from Contaminated Source*	Exposure Point Concentration (mg/kg)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident LW C-CDI (mg/kg-day)	Future Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Benzo(a)pyrene Equivalents	0.5	0.79	5.41E-07	5.05E-06	6.18E-07	1.93E-07	6.90E-08
Arsenic	1	11.9	1.63E-05	1.52E-04	1.86E-05	5.80E-06	2.07E-06
Chromium	1	43.7	5.98E-05	5.58E-04	6.84E-05	2.14E-05	7.63E-06
Copper	1	76.4	1.05E-04	9.76E-04	1.20E-04	3.74E-05	1.33E-05
Manganese	1	188	2.58E-04	2.40E-03	2.94E-04	9.20E-05	3.29E-05
4-Aminobiphenyl	0.1	0.06	8.22E-09	7.67E-08	9.39E-09	2.94E-09	1.05E-09
Antimony	1	4.25	5.82E-06	5.43E-05	6.65E-06	2.08E-06	7.42E-07

Notes:

LWA Lifetime-weighted average; used to calculate carcinogenic CDI, *RAGS Parts A and B.*
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
* Reflects the estimated fraction of the site impacted by the corresponding COPC

Table 10.10.11
Chronic Daily Intakes
Dermal Contact with Surface Soil
AOCs 689 and 690
Charleston Naval Complex
Charleston, South Carolina

Chemical	Exposure Point Concentration (mg/kg)	Fraction Contacted from Contaminated Source *	Dermal Absorption Factor+	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident LWA C-CDI (mg/kg-day)	Future Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Benzo(a)pyrene Equivalent	0.79	0.5	0.01	2.22E-07	7.32E-07	1.39E-07	1.58E-07	5.65E-08
Arsenic	11.9	1	0.001	6.66E-07	2.20E-06	4.17E-07	4.76E-07	1.70E-07
Chromium	43.7	1	0.001	2.45E-06	8.10E-06	1.54E-06	1.75E-06	6.26E-07
Copper	76.4	1	0.001	4.29E-06	1.42E-05	2.68E-06	3.06E-06	1.09E-06
Manganese	188	1	0.001	1.06E-05	3.49E-05	6.61E-06	7.55E-06	2.69E-06
4-Aminobiphenyl	0.06	0.1	0.01	3.37E-09	1.11E-08	2.11E-09	2.41E-09	8.60E-10
Antimony	4.25	1	0.001	2.39E-07	7.87E-07	1.49E-07	1.70E-07	6.09E-08

Notes:
CDI Chronic daily intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
\- The dermal absorption factor was applied to the exposure point concentration to reflect the different trans-dermal migration of inorganic versus organic chemicals
* Reflects the estimated fraction of the site impacted by the corresponding COPC.
LWA Lifetime-weighted average

Table 10.10.12
Toxicological Reference Information
for Chemicals of Potential Concern
AOCs 689 and 690
Charleston Naval Complex
Charleston, South Carolina

Chemical	Oral Reference Dose (mg/kg-day)	Confidence Level	Critical Effect	Uncertainty Factor Oral	Inhalation Reference Dose (mg/kg-day)	Confidence Level	Critical Effect	Uncertainty Factor Inhalation	Oral Slope Factor (kg-day/mg)	Inhalation Slope Factor (kg-day/mg)	Weight of Evidence	Tumor Type
	Non-Carcinogenic Toxicity Data								*Carcinogenic Toxicity Data*			
4-Aminobiphenyl *	0.003 a	M	brain and liver changes	1,000	NA	NA	NA	NA	230 a	235 a	A	bladder cancer
Antimony	0.0004 a	L	whole body/blood increased mortality	1,000	NA	NA	NA	NA	NA	NA	D	NA
Arsenic	0.0003 a	M	hyperpigmentation	3	NA	NA	NA	NA	1.5 a	15.1 a	A	various
BEQ	NA	NA	NA	NA	NA	NA	NA	NA	7.3 a	3.1 c	B2	mutagen
Chromium III	1 a	L	NA	100/10	NA	NA	NA	NA	NA	NA a	D	NA
Chromium VI	0.005 a	L	NA	500	1E-07 c	NA	NA	NA	NA	41 a	A	lung
Copper	0.04 b	NA	NA	NA	NA	NA	NA	NA	NA	NA	D	NA
Manganese (water)	0.02 a	M	neurological effects	1	1.43E-05 a	M	neurological effects	1000	NA	NA	D	NA
Manganese (food)	0.14 a	M	neurological effects	1	1.43E-05 a	M	neurological effects	1000	NA	NA	D	NA

Notes:

* = Toxicity values for benzidene were used as surrogates for 4-aminobiphenyl
a = Integrated Risk Information System (IRIS)
b = Health Effects Assessment Summary Tables (HEAST)
c = EPA NCEA - Cincinnati (provisional)
NA = Not applicable or not available
H = High confidence
L = Low confidence
M = Medium confidence

Arsenic exposure via the ingestion route causes darkening and hardening of the skin in chronically exposed humans. Inhalation exposure to arsenic causes neurological deficits, anemia, and cardiovascular effects (Klaasen, et al., 1986). USEPA set 0.3 μg/kg-day as the RfD for arsenic based on a NOAEL of 0.8 μg/kg-day in a human exposure study. The effects of arsenic on the nervous and cardiovascular systems are primarily associated with acute exposure to higher levels. Exposure to arsenic-containing materials has been shown to cause cancer in humans. Inhalation of these materials can lead to increased lung cancer risk, and ingestion of these materials is associated with increased skin cancer rates.

Arsenic has been classified as a group A carcinogen by USEPA, which established the 1.5 (mg/kg-day)$^{-1}$ SF. As listed in IRIS, the basis for the classification is sufficient evidence from human data. An increased lung cancer mortality was observed in multiple human populations exposed primarily through inhalation. Also, increased mortality from multiple internal organ cancers (liver, kidney, lung, and bladder) and an increased incidence of skin cancer were observed in populations consuming drinking water high in inorganic arsenic. Human milk contains about 3 μg/L arsenic. The tap-water RBC for arsenic is 0.045 μg/L. As listed in IRIS, the critical effects of this chemical are hyperpigmentation, keratosis, and possible vascular complications. The uncertainty factor was determined to be 3 and the modifying factor was determined to be 1.

Benzo(a)pyrene equivalents include the following polynuclear aromatic hydrocarbons (PAHs):

Benzo(a)anthracene	TEF 0.1
Benzo(a)pyrene	TEF 1.0
Benzo(b)fluoranthene	TEF 0.1
Benzo(k)fluoranthene	TEF 0.01
Chrysene	TEF 0.001
Dibenz(a,h)anthracene	TEF 1.0
Indeno(1,2,3-cd)pyrene	TEF 0.1

Some PAHs are toxic to the liver, kidney, and blood. However, the toxic effects of the listed PAHs have not been well established, and there are no RfDs for these PAHs due to a lack of data. All PAHs listed above are classified by USEPA as B2 carcinogens, and their carcinogenicity is addressed relative to that of benzo(a)pyrene, which has an oral SF of 7.3 $(mg/kg\text{-}day)^{-1}$. TEFs, also set by USEPA, are multipliers applied to the detected concentrations, which are subsequently used to calculate excess cancer risk. These multipliers are discussed further in the exposure and toxicity assessment sections. Most carcinogenic PAHs have been so classified due to animal studies using large doses of purified PAHs. There is some doubt as to the validity of these listings, and the SFs listed in USEPA's RBC table are provisional. However, these PAHs are carcinogens when the exposure involves a mixture of other carcinogenic substances (e.g., coal tar, soot, or cigarette smoke). As listed in IRIS, human data that specifically link benzo(a)pyrene to a carcinogenic effect are lacking. There are, however, multiple animal studies in many species demonstrating benzo(a)pyrene to be carcinogenic by numerous routes.

Benzo(a)pyrene has produced positive results in numerous genotoxicity assays. At the June 1992 CRAVE Work Group meeting, a revised risk estimate of benzo(a)pyrene was verified. This section provides information on the aspects of the carcinogenic risk assessment for the agent in question: the USEPA classification and quantitative estimates of exposure. The classification reflects a weight-of-evidence judgment of the likelihood that the agent is a human carcinogen. The quantitative risk estimates are presented in application of a low-dose extrapolation procedure and presented as the risk per mg/kg-day. The unit risk is the quantitative estimate in terms of either risk per $\mu g/L$ drinking water or risk per $\mu g/m^3$ air breathed. The third form in which risk is presented is drinking water or air concentration providing cancer risks of 1 in 10,000 or 1 in 1,000,000. The carcinogenicity background document provides details on the carcinogenicity values found in IRIS. Users are referred to the Oral Reference Dose and Reference Concentration sections for information on long-term toxic effects other than carcinogenicity.

As listed in IRIS, the basis for the dibenz(a,h)anthracene and benzo(b)fluoranthene B2 classification is no human data and sufficient data from animal bioassays. Benzo(b)fluoranthene produced tumors in mice after lung implantation, intraperitoneal or subcutaneous injection, and skin painting. As listed in IRIS, the basis for the benzo(a)anthracene B2 classification is no human data and sufficient data from animal bioassays. Benzo(a)anthracene produced tumors in mice exposed by gavage; intraperitoneal, subcutaneous or intramuscular injection; and topical application. Benzo(a)anthracene produced mutations in bacteria and in mammalian cells, and transformed mammalian cells in culture. As listed in IRIS, the basis for the benzo(k)fluoranthene B2 classification is no human data and sufficient data from animal bioassays. Benzo(k)fluoranthene produced tumors after lung implantation in mice and when administered with a promoting agent in skin-painting studies. Equivocal results have been found in a lung adenoma assay in mice. Benzo(k)fluoranthene is mutagenic in bacteria. (Klaasen, et al., 1986).

Chromium exists in two stable, natural forms: CrIII and hexavalent CrVI. Acute exposure to chromium can result in kidney damage following oral exposure, or damage to the nasal mucosa and septum following inhalation exposure. Chronic inhalation exposure to CrVI has resulted in kidney and respiratory tract damage, as well as excess lung cancer in both animals and humans following occupational exposure. Only CrVI is believed to be carcinogenic by inhalation (IRIS). Oral RfD values for CrIII and CrVI are 1.0 and 5E-03 mg/kg-day, respectively. For CrVI, the RfD is based on liver toxicity in rats. For CrVI, the RfD is based on unspecified pathological changes observed in rat studies. In addition, CrVI is considered a group A carcinogen for inhalation exposures, and an inhalation SF of 41 $(mg/kg\text{-}day)^{-1}$ has been established for the hexavalent form. Vitamin supplements contain approximately 0.025 mg of chromium. As listed in IRIS, no critical effects were observed for CrIII. The uncertainty factor was 100 and the modifying factor was 10. As listed in IRIS, no critical effects were observed for CrVI. The uncertainty factor was 500 and the modifying factor was 1.

Copper is a nutritionally essential element, necessary for many of the body's enzymes. In the past, lead pipes and solder were used for residential water pipes, and resulting lead concentrations in drinking water exceeded USEPA guidelines. Copper has been used to replace water pipes in residences since it is less toxic to man. Short-term exposure to copper can result in anemia (the lack of iron), the breakdown of red blood cells, and liver and kidney lesions. The target organs for copper are the liver, kidney, and red blood cell. Vitamin C reduces copper uptake from the gut, and other substances can also influence copper uptake. Copper fumes can cause metal fume fever (Klaasen, et al., 1986). As listed in IRIS, the D classification is based on no human data, inadequate animal data from assays of copper compounds, and equivocal mutagenicity data. The USEPA RfD is 0.0371 mg/kg-day, which is 2.6 mg/day for the average adult (weighing 70 kg). In typical vitamin supplements, 2 mg/day is the typical dose (NRC, 1989).

Manganese is an essential nutrient, but chronic exposure (0.8 mg/kg-day) causes mental disturbances. Studies have shown that manganese uptake from water is greater than manganese uptake from food, and the elderly appear to be more sensitive than children (Klaasen et al., 1986; Dreisbach et al., 1987). USEPA determined the RfD to be 0.14 mg/kg-day based on dietary uptake. USEPA recommended using a modifying factor of 3 when estimating intake from water. In addition, the body absorbs roughly twice as much manganese in water as it does manganese in food. Because of the different uptake rates in water and food, two RfDs were used in this HHRA — one for water and one for food. The RfDs used are 0.047 and 0.023 mg/kg-day, respectively. Inhalation of manganese dust causes neurological effects and increased incidence of pneumonia. An inhalation RfD was set to 1.43E-05 mg/kg-day.

According to USEPA, manganese cannot be classified as to its carcinogenicity. Therefore, its cancer class is group D. As listed in IRIS, this classification is based on studies that are inadequate to assess the carcinogenicity of manganese. Manganese is considered essential to human health; the typical vitamin supplement dose is 2.5 mg/day. As listed in IRIS, the critical effects of this chemical in water in the oral summary are CNS effects. The uncertainty factor was 1 and the recommended modifying factor of 3 was used to estimate soil and groundwater intake. As listed in IRIS, the critical effect of manganese in the inhalation summary is neuro-behavioral impairment. For inhalation uptake, the uncertainty factor was 1,000 and the modifying factor was 1. The IRIS RfC is 5E-05 mg/m^3.

10.10.6.5 Risk Characterization

Surface Soil Pathways

Exposure to surface soil was evaluated under both future residential and industrial (site worker) scenarios. For each scenario, the incidental ingestion and dermal contact exposure pathways were evaluated. For non-carcinogenic contaminants evaluated for future site residents, hazard was computed separately to address child and adult exposures. Tables 10.10.13 and 10.10.14 present the computed carcinogenic risks and/or HQs associated with the incidental ingestion of and dermal contact with site surface soils, respectively.

Hypothetical Site Residents

The ingestion ILCR (based on the adult and child lifetime-weighted average) for combined AOC 689/690 surface soils is 3E-05. The dermal pathway ILCR is 6E-06. Benzo(a)pyrene equivalents and arsenic were the primary contributors for each pathway. Surface soil incidental ingestion and dermal contact pathway hazard indices were 0.09 and 0.02 for adult residents, and 0.8 and 0.06 for child residents, respectively. Arsenic, antimony, and chromium were the primary contributors.

Table 10.10.13
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
AOCs 689/690
Charleston Naval Complex
Charleston, South Carolina

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used $(mg/kg\text{-}day)^{-1}$	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident lwa ILCR	Future Worker adult Hazard Quotient	Future Worker adult ILCR
Benzo(a)pyrene Equivalents	NA	7.3	ND	ND	4.5E-06	ND	5.0E-07
Arsenic	0.0003	1.5	0.054	0.51	2.8E-05	0.019	3.1E-06
Chromium	0.005	NA	0.012	0.11	ND	0.0043	ND
Copper	0.04	NA	0.0026	0.024	ND	0.00093	ND
Manganese	0.14	NA	0.0018	0.017	ND	0.00066	ND
4-Aminobiphenyl	0.003	230	0.0000027	0.000026	2.2E-06	0.0000010	2.4E-07
Antimony	0.0004	NA	0.015	0.14	ND	0.0052	ND
SUM Hazard Index/ILCR			0.09	0.8	3E-05	0.03	4E-06

Notes:
NA Not available
ND Not determined due to lack of available information
LWA Lifetime-weighted average; used to calculate excess carcinogenic risk derived from *RAGS Part A*.
ILCR Incremental lifetime excess cancer risk

Table 10.10.14
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
AOCs 689 and 690
Charleston Naval Complex
Charleston, South Carolina

Chemical	Dermal Adjustment	Oral RfD Used (mg/kg-day)	Oral SF Used $(mg/kg\text{-}day)^{-1}$	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident LWA ILCR	Future Worker adult Hazard Quotient	Future Worker adult ILCR
Benzo(a)pyrene Equivalents	0.5	NA	14.6	ND	ND	2.0E-06	ND	8.3E-07
Arsenic	0.2	0.00006	7.5	0.011	0.037	3.1E-06	0.0079	1.3E-06
Chromium	0.2	0.001	NA	0.0025	0.0081	ND	0.0018	ND
Copper	0.2	0.008	NA	0.00054	0.0018	ND	0.00038	ND
Manganese	0.2	0.028	NA	0.00038	0.0012	ND	0.00027	ND
4-Aminobiphenyl	0.5	0.0015	460	0.0000022	0.0000074	9.7E-07	0.0000016	4.0E-07
Antimony	0.2	0.00008	NA	0.0030	0.0098	ND	0.0021	ND
SUM Hazard Index/ILCR				0.02	0.06	6E-06	0.01	2E-06

NOTES:
NA Not available
ND Not determined due to lack of available information
LWA Lifetime-weighted average; used to calculate excess carcinogenic risk derived from *RAGS Part A*.
ILCR Incremental lifetime excess cancer risk
- Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)

Future Site Workers

Site worker ILCRs are 4E-06 and 2E-06 for the ingestion and dermal contact pathways, respectively. Arsenic was the primary contributor for both pathways. Surface soil incidental ingestion and dermal contact pathway hazard indices were less than 0.1 for site workers.

The combined AOC is currently heavily vegetated along the roadside with bare ground visible in most roadway areas. The roads are primarily gravel, and coal clinker is suspected to have been used as fill and/or roadbase material. The most common activities observed during the field investigation were recreational in nature (i.e., jogging). Current base reuse plans call for the combined AOC area to be maintained as open buffer (undeveloped land). Should the existing land use remain the same in future use scenarios, the risk/hazard projections presented below would be a significant overestimates.

COCs Identified

USEPA has established a generally acceptable risk range of 1E-04 to 1E-06, and a hazard index threshold of 1.0 (unity). In this HHRA, a COC was considered to be any chemical contributing to a cumulative risk level of 1E-06 or greater and/or a cumulative hazard index above 1.0, and whose individual ILCR exceeds 1E-06 or whose hazard quotient exceeds 0.1. For carcinogens, this approach is relatively conservative, since a cumulative risk level of 1E-04 (and individual ILCR of 1E-06) is recommended by USEPA Region IV as the trigger for establishing COCs. The specified COC selection method was used in order to provide a more comprehensive evaluation of chemicals contributing to carcinogenic risk or non-carcinogenic hazard during the development of remedial goal options. Table 10.10.15 presents the COCs identified for AOCs 689/690.

Table 10.10.15
Summary of Risk and Hazard-based COCs
AOCs 689 and 690
Charleston Naval Complex
Charleston, South Carolina

Medium	Exposure Pathway		Future Resident Adult Hazard Quotient	Future Resident Child Hazard Quotient	Future Resident LWA ILCR	Site Worker Hazard Quotient	Site Worker ILCR	Identification of COCs	
Surface Soil	Incidental Ingestion	Benzo(a)pyrene Equivalents	ND	ND	4.5E-06	ND	5.0E-07	2	
		Arsenic	0.054	0.51	2.8E-05	0.019	3.1E-06	2	4
		Chromium	0.012	0.11	ND	0.0043	ND		
		Copper	0.0026	0.024	ND	0.00093	ND		
		Manganese	0.0018	0.017	ND	0.00066	ND		
		4-Aminobiphenyl	0.0000027	0.000026	2.2E-06	0.0000010	2.4E-07	2	
		Antimony	0.015	0.14	ND	0.0052	ND		
	Dermal Contact	Benzo(a)pyrene Equivalents	ND	ND	2.0E-06	ND	8.3E-07	2	
		Arsenic	0.011	0.037	3.1E-06	0.0079	1.3E-06	2	4
		Chromium	0.0025	0.0081	ND	0.0018	ND		
		Copper	0.00054	0.0018	ND	0.00038	ND		
		Manganese	0.00038	0.0012	ND	0.00027	ND		
		4-Aminobiphenyl	0.0000022	0.0000074	9.7E-07	0.0000016	4.0E-07		
		Antimony	0.0030	0.0098	ND	0.0021	ND		
Surface Soil Pathway Sum			0.10	0.9	4E-05	0.04	6E-06		

Notes:
ND = not determined due to the lack of available risk information.
ILCR = incremental excess lifetime cancer risk
HI = hazard index
LWA = lifetime-weighted average
1- Chemical is a COC by virtue of projected child residence non-carcinogenic hazard.
2- Chemical is a COC by virtue of projected future resident lifetime ILCR.
3- Chemical is a COC by virtue of projected site worker non-carcinogenic hazard.
4- Chemical is a COC by virtue of projected site worker ILCR.

Surface Soils

Hypothetical Site Residents (future land use)

BEQs, arsenic, and 4-aminobiphenyl were identified as COCs for this scenario based on their contribution to the cumulative ILCR.

Future Site Workers (current land use)

Arsenic was identified as a COC for this scenario based on its contribution to the cumulative ILCR.

Extent of COCs

Arsenic was detected in 37 of 39 surface soil samples, with a maximum concentration of 28.7 mg/kg at 690SB029. All 37 detections were above the RBC for arsenic (0.43 mg/kg) and two were also above the background value for arsenic (21.6 mg/kg). 4-aminobiphenyl was detected in one of 23 surface soil samples (690SB020), at a concentration exceeding the RBC (2.8 μg/kg).

Benzo(a)pyrene equivalents were reported at only 7 of 41 locations at concentrations above the residential RBC (0.087 mg/kg), so chronic exposure at the maximum reported concentration is unlikely. The most concentrated area of BEQs exceedances included sample locations 690SB018, 690SB031 and 690SB032, along the west bank of West Road. This area is a relatively steep sloped bank which merges into tidal marsh at the base. It can be concluded with some certainty that the area could not be developed without extensive fill and regrading. As a result, a focused assessment of this area was not warranted.

10.10.6.6 Risk Uncertainty

Characterization of Exposure Setting and Identification of Exposure Pathways

The potential for high bias in exposure assessment is introduced through exposure setting and pathway selection due to the highly conservative assumptions (i.e., future residential use) recommended by USEPA Region IV. The exposure assumptions made in the future site worker scenario are highly conservative and would tend to overestimate exposure. The area found to be impacted by COPCs ranges from heavily vegetated areas along the roadside to bare soil and gravel. Current site workers are infrequently exposed to surface soils, although direct contact is not inhibited by site features.

Residential use of the site is not expected or likely, based on current site uses and the nature of surrounding area. Current reuse plans call for continued non-residential use of Zone I, with AOCs 689/690 specifically slated to become open buffer space. If this area were to be used as a residential site, the regrading for development would likely change existing conditions. For example, surface soil would be covered with landscaping soil, a driveway, and/or a house. As discussed above, the impacted areas west of West and Least Tern Roads would require extensive fill prior to development. Consequently, exposure to current surface soil conditions would not be likely under a true future residential scenario. These factors indicate that exposure pathways assessed in this HHRA generally overestimate the risk and hazard posed to site workers and future site residents.

Determination of Exposure Point Concentrations

The BEQs, arsenic, chromium, copper, manganese, and antimony UCLs were used as the EPCs for these relatively widespread surface soil constituents. A hot-spot approach was used to project chronic daily intake for 4-aminobiphenyl, using the maximum concentration applied as the EPC and modified by a corresponding FI/FC factor.

Frequency of Detection and Spatial Distribution

Arsenic was detected in 37 of 39 surface soil samples collected at AOCs 689/690, and was detected above its background concentration in two of these samples. The UCL value applied as the EPC for arsenic was well below the background concentration. Benzo(a)pyrene equivalents were detected in 17 of 41 surface soil samples and exceeded the residential RBC in seven samples (690SB007, 690SB010, 690SB18, 690SB029, 690SB031, 690SB032, and 690SB042). The EPC for BEQs was 0.79 mg/kg, which was the UCL. 4-aminobiphenyl was detected in only one of 23 surface soil samples (690SB020) at a concentration above the residential RBC. The EPC for 4-aminobiphenyl was established as the maximum detected (0.06 mg/kg at location 690SB020). Exceedances for BEQs and 4-aminobiphenyl were not co-located in any instance. FI/FC factors were derived for each to account for limited areal extent. These factors were conservatively estimated based upon frequency of detection and approximation of the area impacted.

The FI/FCs for BEQs and 4-aminobiphenyl were applied to account for the scattered nature of hits above the residential RBCs over the area of investigation. These results support the premise that materials may have been discarded in a haphazard manner along the of Least Tern and West Roads. Where there was visual evidence of potential surface soil impacts, sampling locations were biased in an attempt to identify grossly contaminated areas. The hot-spot approach was considered a more reasonable approximation of true chronic exposure potential, and did not exclude any COPC from consideration based on lack of spatial correlation.

The benzo(a)pyrene equivalents impacted soil samples were collected along the west bank of West Road. This area is a relatively steep sloped bank which merges into tidal marsh at the base. It can be concluded with some certainty that the area could not be developed without extensive fill and regrading. As a result, a focused assessment of this area was not warranted.

Quantification of Risk/Hazard

Many site-specific factors affect the uncertainty of this assessment and cause upward bias in the risk and hazard estimates. Exposure pathway-specific sources of uncertainty are discussed below.

Of the CPSSs screened from formal assessment, none of these eliminated was reported at a concentration close to the corresponding RBC (i.e., within approximately 10% of the RBC). This minimizes the likelihood of potentially significant cumulative risk/hazard with respect to the eliminated CPSSs. Aluminum exceeded its RBC, but was eliminated from formal assessment because it did not exceed the corresponding background concentration.

Central tendency (CT) analysis was not formally performed for AOCs 689/690 surface soil, but a simplified approach was taken to assess the potential influences of CT assumptions. The CT assumption for residential exposure duration is nine years, compared to the 30 year assumption for RME. The exposure frequency assumption is 234 days/year compared to 350 days/year RME. Standard CT ingestion rate estimates are 50 % lower for child than adult receptors. If all other exposure assumptions remain fixed, application of the CT exposure duration and frequency as well as ingestion rate would result in risk projections 90% below the RME. At CT, the residential surface soil pathway-related risk (incidental ingestion and dermal contact) would drop from 4E-05 to almost 4E-06.

Although the future land use of the combined AOCs is unknown, both the future industrial (worker) and residential exposure scenarios were assessed in this HHRA. As previously discussed, it is likely that these scenarios would lead to overestimate risk and/or hazard.

Background-Related Risk

Aluminum was detected in surface soil at concentrations above its RBC. This element was eliminated from consideration in the risk assessment based on comparison to its background value.

It is not unusual for naturally occurring or background concentrations of some elements to exceed risk-based concentrations. The following addresses the risk/hazard associated with the background concentration of aluminum.

The maximum surface soil concentration of aluminum (22,400 mg/kg) equates with hazard quotients of 0.3 and 0.02 for the resident child and site worker, respectively. The background value for aluminum (27,400 mg/kg) results in hazard quotients of 0.4 and 0.02 for the resident child and site worker, respectively.

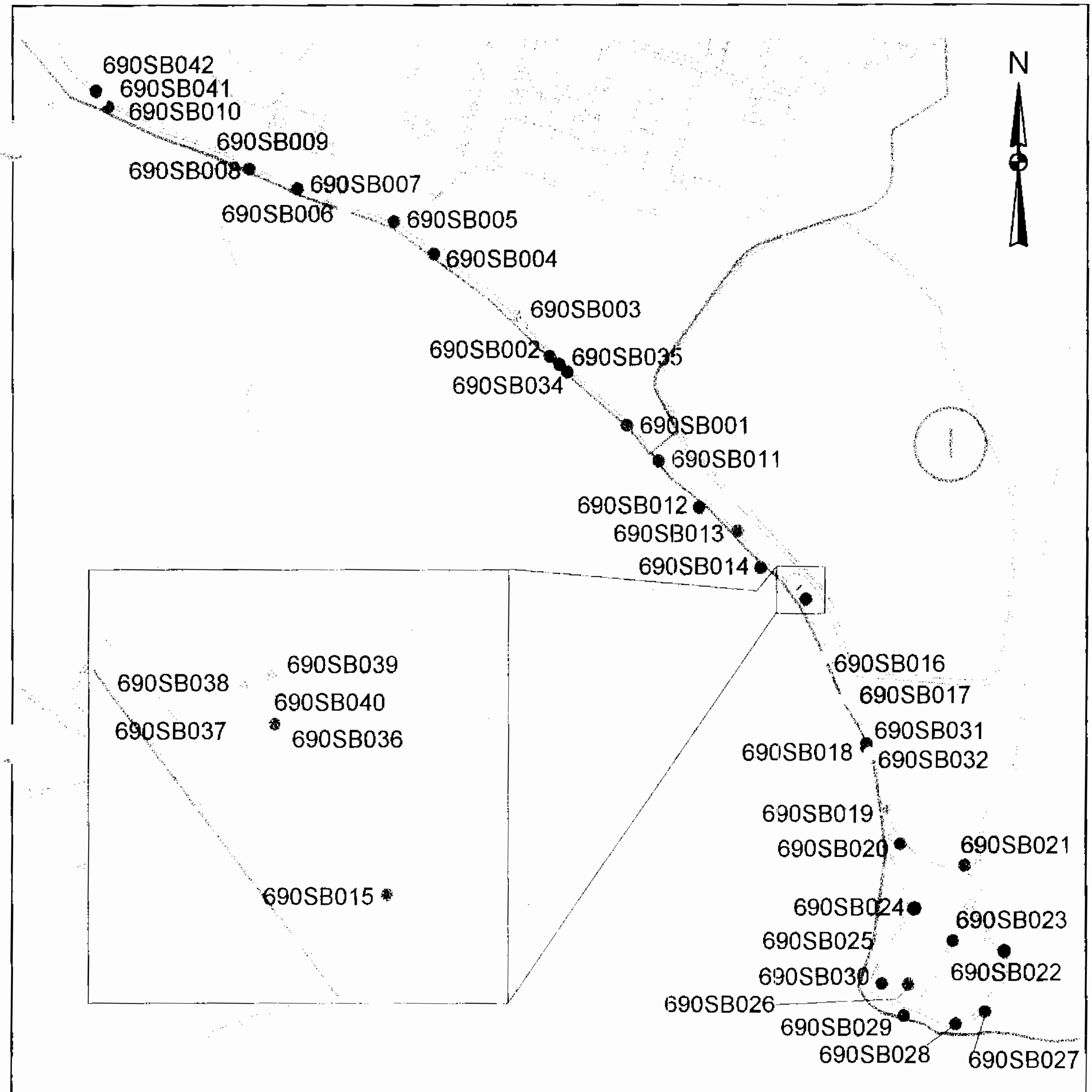
10.10.6.7 Risk Summary

The risk and hazard posed by contaminants at AOCs 689/690 were assessed for the hypothetical future site worker and the site resident under reasonable maximum exposure assumptions. This HHRA assessed the incidental ingestion and dermal contact pathways for surface soils. Table 10.10.16 presents the risk summary for each pathway/receptor group evaluated.

Soil — Residential Scenario

The residential soil pathway COCs identified for AOCs 689/690 are benzo(a)pyrene equivalents, arsenic, and 4-aminobiphenyl. Figures 10.10.14 and 10.10.15 show point risk and hazard estimates for combined AOC 690 based on surface soil exposure pathways under a future residential scenario. Table 10.10.17 summarizes the risk and hazard contribution of each COPC at each sample location.

The point risk map is based on the unlikely assumption that a future site resident will be chronically exposed to specific points. Exposure to surface soil conditions would more likely the result of uniform exposure to the soil conditions of the entire site (or exposure unit area) rather than specific points. Given this, the risk maps and summary table are useful to illustrate spatial distribution of the chemicals driving risk estimates.



LEGEND

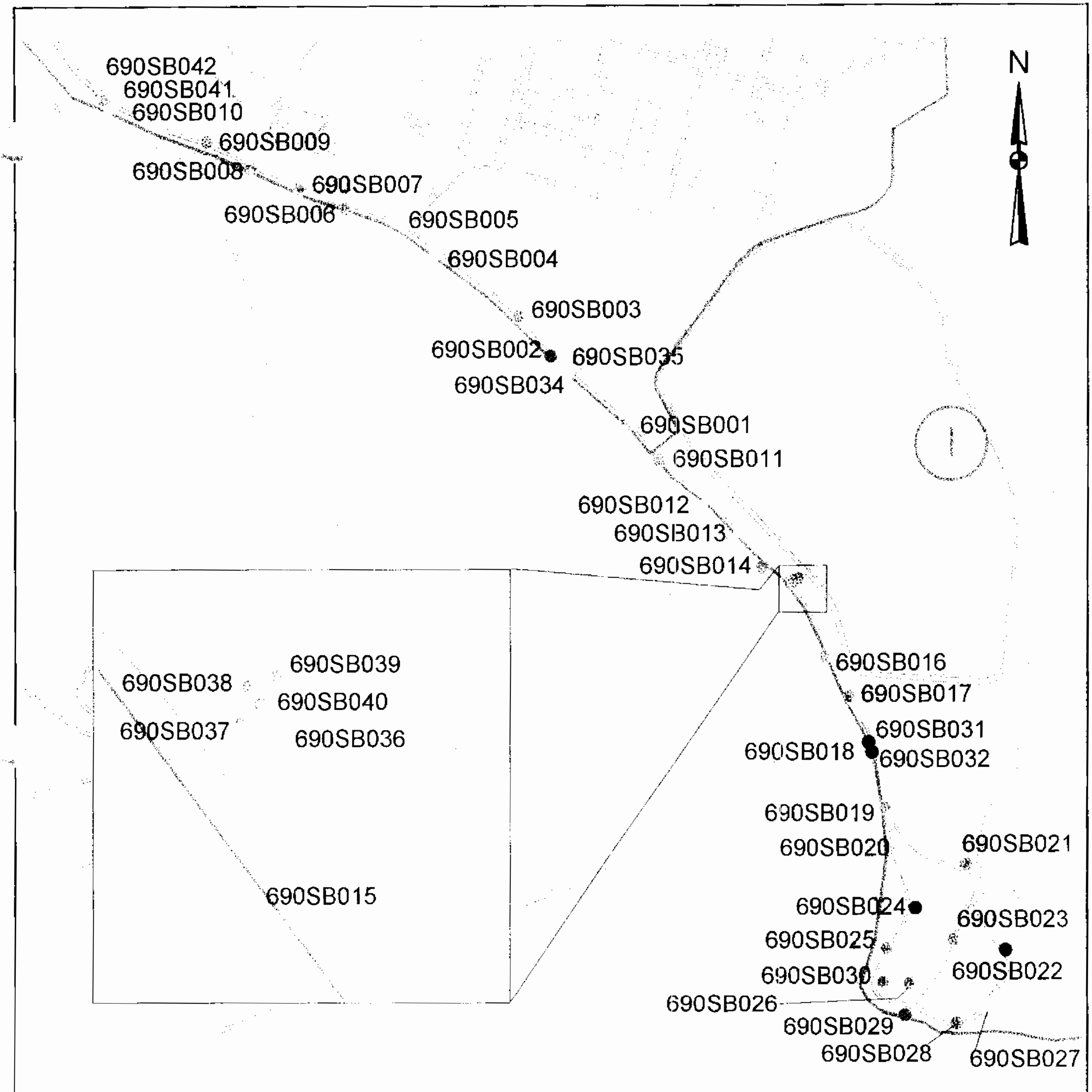
- NO COPCs
- < 1E-6
- 1E-6 to 5E-6
- 5E-6 to 1E-5
- 1E-5 to 1E-4
- > 1E-4

600 0 600 1200 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.10.14
ZONE I
AOC 690

SURFACE SOIL POINT RISK
RESIDENTIAL SCENARIO



LEGEND

- NO COPCs
- 0 to 0.1
- 0.1 to 0.5
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600 0 600 1200 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.10.15
ZONE I
AOC 690

SURFACE SOIL HAZARD INDEX
RESIDENTIAL SCENARIO

Table 10.10.16
Summary of Risk and Hazard
AOCs 689 and 690
Charleston Naval Complex
Charleston, South Carolina

Medium	Exposure Pathway	HI Resident (Adult)	HI Resident (Child)	ILCR Resident (LWA)	HI (Worker)	ILCR (Worker)
Surface Soil	Incidental Ingestion	0.09	0.8	3E-05	0.03	4E-06
	Dermal Contact	0.02	0.06	6E-06	0.01	2E-06
Sum of All Pathways		0.10	0.9	4E-05	0.04	6E-06

Notes:
ND = not determined due to the lack of available information.
ILCR = incremental excess lifetime cancer risk
HI = hazard index
LWA = lifetime-weighted average

Table 10.10.17
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
AOCs 689 and 690
Charleston Naval Complex
Charleston, South Carolina

AOCs	Location	Parameter	Concentration	Units	Hazard Index	Risk (E-06)
690	B001	Arsenic (As)	7.5	mg/kg	0.343	19.59
690	B001	Chromium (Cr)	22.5	mg/kg	0.062	NA
690	B001	Copper (Cu)	87.6	mg/kg	0.030	NA
690	B001	Manganese (Mn)	143	mg/kg	0.042	NA
		Total			0.476	19.59
690	B002	Arsenic (As)	26.3	mg/kg	1.202	68.70
690	B002	Benzo(a)pyrene equivalents	9.47	ug/kg	NA	0.16
690	B002	Chromium (Cr)	19.85	mg/kg	0.054	NA
690	B002	Copper (Cu)	35.45	mg/kg	0.012	NA
690	B002	Manganese (Mn)	36.9	mg/kg	0.011	NA
		Total			1.279	68.85
690	B003	Arsenic (As)	1.7	mg/kg	0.078	4.44
690	B003	Chromium (Cr)	7.7	mg/kg	0.021	NA
690	B003	Manganese (Mn)	199	mg/kg	0.058	NA
		Total			0.157	4.44
690	B004	Arsenic (As)	11.2	mg/kg	0.512	29.25
690	B004	Benzo(a)pyrene equivalents	8.6	ug/kg	NA	0.14
690	B004	Chromium (Cr)	25.7	mg/kg	0.070	NA
690	B004	Copper (Cu)	46.5	mg/kg	0.016	NA
690	B004	Manganese (Mn)	245	mg/kg	0.071	NA
		Total			0.670	29.40
690	B005	Arsenic (As)	5.8	mg/kg	0.265	15.15
690	B005	Chromium (Cr)	132	mg/kg	0.362	NA
690	B005	Copper (Cu)	87.3	mg/kg	0.030	NA
690	B005	Manganese (Mn)	162	mg/kg	0.047	NA
		Total			0.704	15.15
690	B006	Arsenic (As)	2.1	mg/kg	0.096	5.49
690	B006	Chromium (Cr)	21.2	mg/kg	0.058	NA
690	B006	Manganese (Mn)	62.7	mg/kg	0.018	NA
		Total			0.172	5.49
690	B007	Arsenic (As)	2.2	mg/kg	0.101	5.75
690	B007	Benzo(a)pyrene equivalents	858.65	ug/kg	NA	14.22
690	B007	Chromium (Cr)	9.5	mg/kg	0.026	NA
690	B007	Manganese (Mn)	58.6	mg/kg	0.017	NA
		Total			0.144	19.97
690	B008	Arsenic (As)	4.7	mg/kg	0.215	12.28
690	B008	Chromium (Cr)	11.9	mg/kg	0.033	NA
690	B008	Copper (Cu)	24.2	mg/kg	0.008	NA
690	B008	Manganese (Mn)	203	mg/kg	0.059	NA
		Total			0.315	12.28
690	B009	Arsenic (As)	3.6	mg/kg	0.165	9.40
690	B009	Chromium (Cr)	66.2	mg/kg	0.182	NA

Table 10.10.17
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
AOCs 689 and 690
Charleston Naval Complex
Charleston, South Carolina

AOCs	Location	Parameter	Concentration	Units	Hazard Index	Risk (E-06)
690	B009	Manganese (Mn)	147	mg/kg	0.043	NA
		Total			0.389	9.40
690	B010	Arsenic (As)	7.4	mg/kg	0.338	19.33
690	B010	Benzo(a)pyrene equivalents	317.63	ug/kg	NA	5.26
690	B010	Chromium (Cr)	48	mg/kg	0.132	NA
690	B010	Copper (Cu)	321	mg/kg	0.109	NA
690	B010	Manganese (Mn)	135	mg/kg	0.039	NA
		Total			0.618	24.59
690	B011	Arsenic (As)	6.7	mg/kg	0.306	17.50
690	B011	Chromium (Cr)	36.4	mg/kg	0.100	NA
690	B011	Copper (Cu)	37.1	mg/kg	0.013	NA
690	B011	Manganese (Mn)	178	mg/kg	0.052	NA
		Total			0.471	17.50
690	B012	Arsenic (As)	9.8	mg/kg	0.448	25.60
690	B012	Benzo(a)pyrene equivalents	78.35	ug/kg	NA	1.30
690	B012	Chromium (Cr)	19.7	mg/kg	0.054	NA
690	B012	Copper (Cu)	16.1	mg/kg	0.005	NA
690	B012	Manganese (Mn)	60.4	mg/kg	0.018	NA
		Total			0.525	26.90
690	B013	Arsenic (As)	9.2	mg/kg	0.421	24.03
690	B013	Chromium (Cr)	55.9	mg/kg	0.153	NA
690	B013	Copper (Cu)	32.5	mg/kg	0.011	NA
690	B013	Manganese (Mn)	289	mg/kg	0.084	NA
		Total			0.669	24.03
690	B014	Arsenic (As)	6.4	mg/kg	0.293	16.72
690	B014	Benzo(a)pyrene equivalents	57.66	ug/kg	NA	0.95
690	B014	Chromium (Cr)	31.4	mg/kg	0.086	NA
690	B014	Copper (Cu)	20.4	mg/kg	0.007	NA
690	B014	Manganese (Mn)	111	mg/kg	0.032	NA
		Total			0.418	17.67
690	B015	Arsenic (As)	9.7	mg/kg	0.443	25.34
690	B015	Benzo(a)pyrene equivalents	74.17	ug/kg	NA	1.23
690	B015	Chromium (Cr)	32.5	mg/kg	0.089	NA
690	B015	Chromium (Hexavalent)	3.98	mg/kg	0.011	NA
690	B015	Copper (Cu)	20.25	mg/kg	0.007	NA
690	B015	Manganese (Mn)	281.5	mg/kg	0.082	NA
		Total			0.632	26.56
690	B016	Arsenic (As)	1.9	mg/kg	0.087	4.96
690	B016	Benzo(a)pyrene equivalents	4.64	ug/kg	NA	0.08
690	B016	Chromium (Cr)	131	mg/kg	0.359	NA
690	B016	Copper (Cu)	35.8	mg/kg	0.012	NA
690	B016	Manganese (Mn)	54.4	mg/kg	0.016	NA
		Total			0.474	5.04

Table 10.10.17
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
AOCs 689 and 690
Charleston Naval Complex
Charleston, South Carolina

AOCs	Location	Parameter	Concentration	Units	Hazard Index	Risk (E-06)
690	B017	Arsenic (As)	3.6	mg/kg	0.165	9.40
690	B017	Chromium (Cr)	33.4	mg/kg	0.092	NA
690	B017	Copper (Cu)	15.2	mg/kg	0.005	NA
690	B017	Manganese (Mn)	25.8	mg/kg	0.008	NA
		Total			0.269	9.40
690	B018	Arsenic (As)	10.7	mg/kg	0.489	27.95
690	B018	Benzo(a)pyrene equivalents	1788.6	ug/kg	NA	29.62
690	B018	Chromium (Cr)	29.4	mg/kg	0.081	NA
690	B018	Copper (Cu)	74.4	mg/kg	0.025	NA
690	B018	Manganese (Mn)	76.3	mg/kg	0.022	NA
		Total			0.617	57.57
690	B019	Arsenic (As)	1.3	mg/kg	0.059	3.40
690	B019	Benzo(a)pyrene equivalents	5.98	ug/kg	NA	0.10
690	B019	Chromium (Cr)	42.7	mg/kg	0.117	NA
690	B019	Copper (Cu)	90.7	mg/kg	0.031	NA
690	B019	Manganese (Mn)	82.2	mg/kg	0.024	NA
		Total			0.231	3.49
690	B020	Arsenic (As)	11.8	mg/kg	0.539	30.82
690	B020	Benzo(a)pyrene equivalents	60.98	ug/kg	NA	1.01
690	B020	Chromium (Cr)	26.5	mg/kg	0.073	NA
690	B020	Copper (Cu)	18.5	mg/kg	0.006	NA
690	B020	Manganese (Mn)	77.5	mg/kg	0.023	NA
		Total			0.641	31.83
690	B021	Arsenic (As)	6.7	mg/kg	0.306	17.50
690	B021	Benzo(a)pyrene equivalents	7.57	ug/kg	NA	0.13
690	B021	Chromium (Cr)	19.3	mg/kg	0.053	NA
690	B021	Copper (Cu)	23	mg/kg	0.008	NA
690	B021	Manganese (Mn)	113	mg/kg	0.033	NA
		Total			0.400	17.63
690	B022	Benzo(a)pyrene equivalents	0.39	ug/kg	NA	0.01
690	B022	Chromium (Cr)	6.5	mg/kg	0.018	NA
690	B022	Antimony (Sb)	0.28	mg/kg	0.010	NA
690	B022	Copper (Cu)	2.1	mg/kg	0.001	NA
690	B022	Manganese (Mn)	14	mg/kg	0.004	NA
		Total			0.032	0.01
690	B023	Arsenic (As)	7.9	mg/kg	0.361	20.63
690	B023	Chromium (Cr)	21.8	mg/kg	0.060	NA
690	B023	Copper (Cu)	9.3	mg/kg	0.003	NA
690	B023	Manganese (Mn)	150	mg/kg	0.044	NA
		Total			0.468	20.63
690	B024	Chromium (Cr)	4.1	mg/kg	0.011	NA
690	B024	Copper (Cu)	0.72	mg/kg	0.000	NA
690	B024	Manganese (Mn)	8.7	mg/kg	0.003	NA
		Total			0.014	NA

Table 10.10.17
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
AOCs 689 and 690
Charleston Naval Complex
Charleston, South Carolina

AOCs	Location	Parameter	Concentration	Units	Hazard Index	Risk (E-06)
690	B025	Arsenic (As)	2.6	mg/kg	0.119	6.79
690	B025	Chromium (Cr)	10.3	mg/kg	0.028	NA
690	B025	Copper (Cu)	16.7	mg/kg	0.006	NA
690	B025	Manganese (Mn)	83.2	mg/kg	0.024	NA
		Total			0.177	6.79
690	B026	Arsenic (As)	5.5	mg/kg	0.251	14.37
690	B026	Chromium (Cr)	57.6	mg/kg	0.158	NA
690	B026	Chromium (Hexavalent)	0.512	mg/kg	0.001	NA
690	B026	Copper (Cu)	17.3	mg/kg	0.006	NA
690	B026	Manganese (Mn)	54.2	mg/kg	0.016	NA
		Total			0.432	14.37
690	B027	Arsenic (As)	8.2	mg/kg	0.375	21.42
690	B027	Chromium (Cr)	38.1	mg/kg	0.104	NA
690	B027	Copper (Cu)	25.2	mg/kg	0.009	NA
690	B027	Manganese (Mn)	196	mg/kg	0.057	NA
		Total			0.545	21.42
690	B028	Arsenic (As)	7	mg/kg	0.320	18.28
690	B028	Chromium (Cr)	27.6	mg/kg	0.076	NA
690	B028	Copper (Cu)	14	mg/kg	0.005	NA
690	B028	Manganese (Mn)	125	mg/kg	0.036	NA
		Total			0.437	18.28
690	B029	Arsenic (As)	28.7	mg/kg	1.312	74.96
690	B029	Benzo(a)pyrene equivalents	24.57	ug/kg	NA	1.72
690	B029	Chromium (Cr)	19.3	mg/kg	0.053	NA
690	B029	Copper (Cu)	22.3	mg/kg	0.008	NA
690	B029	Manganese (Mn)	172	mg/kg	0.050	NA
		Total			1.423	76.68
690	B030	Arsenic (As)	5.3	mg/kg	0.242	13.84
690	B030	Chromium (Cr)	21.2	mg/kg	0.058	NA
690	B030	Copper (Cu)	12.6	mg/kg	0.004	NA
690	B030	Manganese (Mn)	142	mg/kg	0.041	NA
		Total			0.346	13.84
690	B031	Benzo(a)pyrene equivalents	743.76	ug/kg	NA	12.32
690	B032	Benzo(a)pyrene equivalents	364.99	ug/kg	NA	6.04
690	B034	Arsenic (As)	10	mg/kg	0.457	26.12
690	B034	Antimony (Sb)	24.5	mg/kg	0.840	NA
690	B034	Chromium (Cr)	58.7	mg/kg	0.161	NA
690	B034	Copper (Cu)	123	mg/kg	0.042	NA
690	B034	Manganese (Mn)	112	mg/kg	0.033	NA
		Total			1.532	26.12
690	B035	Arsenic (As)	7.5	mg/kg	0.343	19.59

Table 10.10.17
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
AOCs 689 and 690
Charleston Naval Complex
Charleston, South Carolina

AOCs	Location	Parameter	Concentration	Units	Hazard Index	Risk (E-06)
690	B035	Chromium (Cr)	45.4	mg/kg	0.125	NA
690	B035	Copper (Cu)	37.4	mg/kg	0.013	NA
690	B035	Manganese (Mn)	106	mg/kg	0.031	NA
		Total			0.511	19.59
690	B036	Arsenic (As)	10.9	mg/kg	0.498	28.47
690	B036	Chromium (Cr)	43.7	mg/kg	0.120	NA
690	B036	Copper (Cu)	20.8	mg/kg	0.007	NA
690	B036	Manganese (Mn)	461	mg/kg	0.134	NA
		Total			0.760	28.47
690	B037	Arsenic (As)	3.35	mg/kg	0.153	8.75
690	B037	Antimony (Sb)	0.46	mg/kg	0.016	NA
690	B037	Chromium (Cr)	26.85	mg/kg	0.074	NA
690	B037	Copper (Cu)	8.85	mg/kg	0.003	NA
690	B037	Manganese (Mn)	268	mg/kg	0.078	NA
		Total			0.324	8.75
690	B038	Arsenic (As)	1.5	mg/kg	0.069	3.92
690	B038	Chromium (Cr)	14.3	mg/kg	0.039	NA
690	B038	Copper (Cu)	12.7	mg/kg	0.004	NA
690	B038	Manganese (Mn)	42.9	mg/kg	0.013	NA
		Total			0.125	3.92
690	B039	Arsenic (As)	1.5	mg/kg	0.069	3.92
690	B039	Antimony (Sb)	0.57	mg/kg	0.020	NA
690	B039	Chromium (Cr)	13.9	mg/kg	0.038	NA
690	B039	Copper (Cu)	15.2	mg/kg	0.005	NA
690	B039	Manganese (Mn)	26	mg/kg	0.008	NA
		Total			0.139	3.92
690	B040	Arsenic (As)	3.7	mg/kg	0.169	9.66
690	B040	Chromium (Cr)	28.3	mg/kg	0.078	NA
690	B040	Copper (Cu)	28.1	mg/kg	0.010	NA
690	B040	Manganese (Mn)	152	mg/kg	0.044	NA
		Total			0.301	9.66
690	B041	Arsenic (As)	2.3	mg/kg	0.105	6.01
690	B041	Chromium (Cr)	10.4	mg/kg	0.029	NA
690	B041	Copper (Cu)	15.8	mg/kg	0.005	NA
690	B041	Manganese (Mn)	36.8	mg/kg	0.011	NA
		Total			0.150	6.01
690	B042	Arsenic (As)	2.8	mg/kg	0.128	7.31
690	B042	Benzo(a)pyrene equivalents	245.23	ug/kg	NA	4.06
690	B042	Chromium (Cr)	40	mg/kg	0.110	NA
690	B042	Copper (Cu)	305	mg/kg	0.104	NA
690	B042	Manganese (Mn)	125	mg/kg	0.036	NA
		Total			0.378	11.37

Most sample locations yielded ILCRs that were greater than 1E-06. Arsenic was the primary contributor to risk, and BEQs were the secondary contributors. Risk estimates at the combined AOCs ranged from 1E-08 (690SB022) to 8E-05 (690SB029), with a mean risk estimate of 2E-05. Arsenic and chromium were primary contributors to hazard estimates at locations that yielded a hazard index above unity. Copper was secondary contributor. Hazard index estimates ranged from 0.01 (690SB024) to 1 (690SB029), with a mean hazard estimate of 0.4.

Soil — Site Worker Scenario

The industrial soil pathway COC identified for AOCs 689/690 is arsenic. Figure 10.10.16 gives point risk estimates based on soil exposure pathways under a future site worker/industrial scenario. Table 10.10.18 summarizes the risk and hazard contribution of each COPC at each sample location.

Most sample locations yielded ILCRs greater than 1E-06. Arsenic was the primary contributor to risk, and BEQS were secondary contributors. Risk estimates ranged from 1E-09 (690SB022) to 1E-05 (690SB029), with a mean risk estimate of 3E-06.

Arsenic was the primary contributor to hazard estimates; however, hazard indices did not exceed unity at any location for the industrial scenario. Hazard index estimates ranged from 0.0007 (690SB024) to 0.08 (690SB034), with a mean hazard estimate of 0.02.

10.10.6.8 Remedial Goal Options

RGOs for carcinogens were based on the lifetime-weighted average future site resident and future site worker, as presented in Table 10.10.19. Hazard-based RGOs for the residential scenario were calculated based on the hypothetical child receptor.

10.10.7 Corrective Measures Considerations

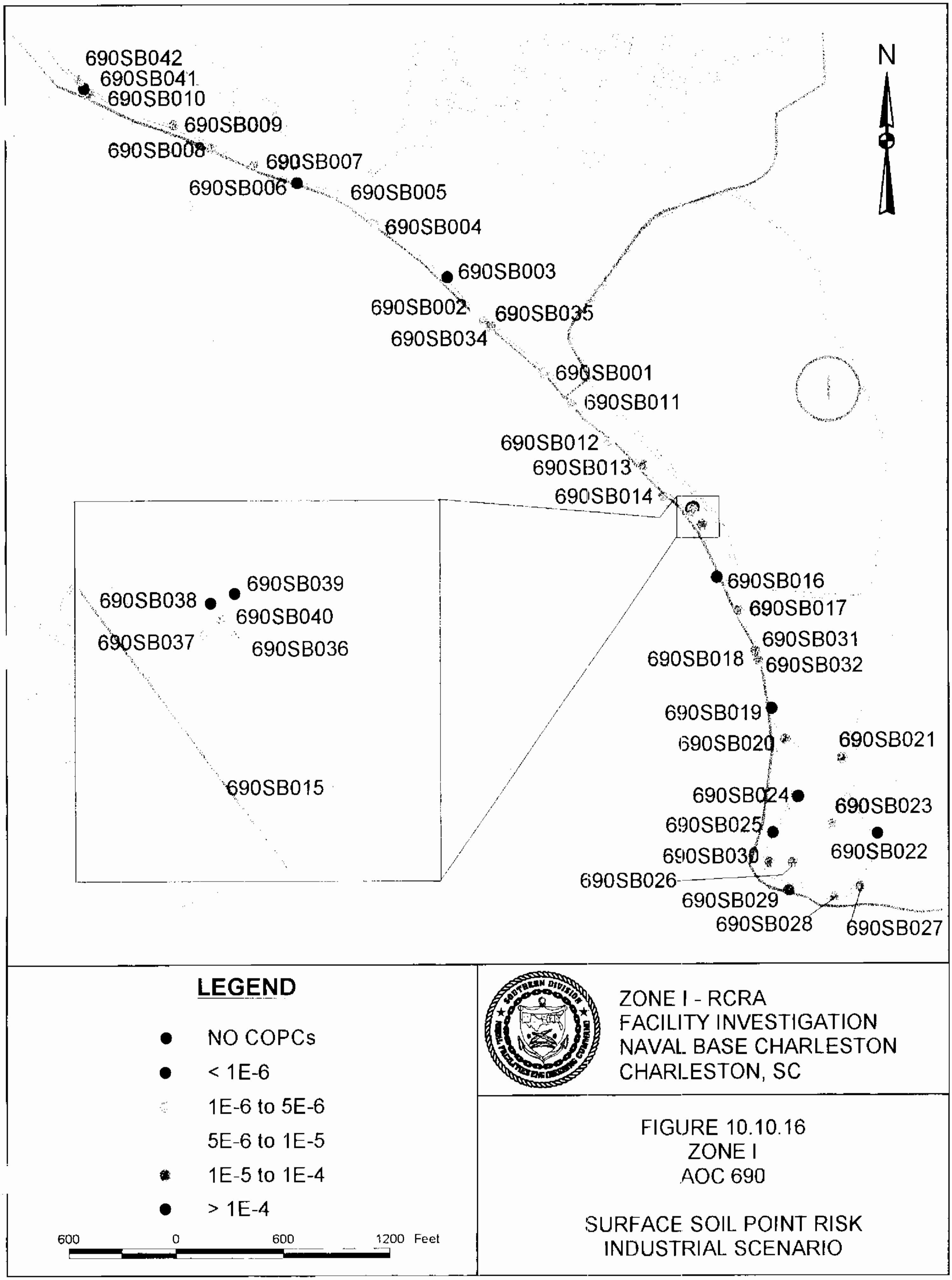
Based on the analytical results and the human health risk assessment for AOC 689/690, COCs requiring further evaluation through the CMS process have been identified for surface soil.

The site is in a moderately developed urban setting and risk to human health was evaluated under both future residential and industrial (site worker) scenarios. For these scenarios, the incidental ingestion and dermal contact exposure pathways were evaluated. Hazard was evaluated for noncarcinogenic contaminants through incidental ingestion and dermal contact as well.

As recommended by SCDHEC, a COC is considered to be any chemical contributing to a cumulative risk level of 1E-06 or greater and/or a cumulative hazard index above 1.0, and whose individual risk exceeds 1E-06 or whose hazard quotient exceeds 0.1.

Arsenic, BEQs, chromium, copper, and 4-aminobiphenyl were identified as soil pathway COCs for AOC 689/690. Table 10.10.20 presents cumulative and COC-specific exposure risks and hazard quotients.

Risk-based remedial goals for surface soil are presented in Table 10.10.19. Potential corrective measures for soil are presented in Table 10.10.21.



ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.10.16
ZONE I
AOC 690

SURFACE SOIL POINT RISK
INDUSTRIAL SCENARIO

Table 10.10.18
Point Estimates of Risk and Hazard - Surface Soil Pathways
Industrial Scenario
AOCs 689 and 690
Charleston Naval Complex
Charleston, South Carolina

AOC	Location	Parameter	Concentration	Units	Hazard Index	Risk (E-06)
690	B001	Arsenic (As)	7.5	mg/kg	0.0172	2.77
690	B001	Chromium (Cr)	22.5	mg/kg	0.0031	NA
690	B001	Copper (Cu)	87.6	mg/kg	0.0015	NA
690	B001	Manganese (Mn)	143	mg/kg	0.0021	NA
		Total			0.0239	2.77
690	B002	Arsenic (As)	26.3	mg/kg	0.0605	9.72
690	B002	Benzo(a)pyrene equivalents	9.47	ug/kg	NA	0.03
690	B002	Chromium (Cr)	19.85	mg/kg	0.0027	NA
690	B002	Copper (Cu)	35.45	mg/kg	0.0006	NA
690	B002	Manganese (Mn)	36.9	mg/kg	0.0005	NA
		Total			0.0644	9.75
690	B003	Arsenic (As)	1.7	mg/kg	0.0039	0.63
690	B003	Chromium (Cr)	7.7	mg/kg	0.0011	NA
690	B003	Manganese (Mn)	199	mg/kg	0.0029	NA
		Total			0.0079	0.63
690	B004	Arsenic (As)	11.2	mg/kg	0.0258	4.14
690	B004	Benzo(a)pyrene equivalents	8.6	ug/kg	NA	0.03
690	B004	Chromium (Cr)	25.7	mg/kg	0.0035	NA
690	B004	Copper (Cu)	46.5	mg/kg	0.0008	NA
690	B004	Manganese (Mn)	245	mg/kg	0.0036	NA
		Total			0.0337	4.17
690	B005	Arsenic (As)	5.8	mg/kg	0.0133	2.14
690	B005	Chromium (Cr)	132	mg/kg	0.0182	NA
690	B005	Copper (Cu)	87.3	mg/kg	0.0015	NA
690	B005	Manganese (Mn)	162	mg/kg	0.0024	NA
		Total			0.0354	2.14
690	B006	Arsenic (As)	2.1	mg/kg	0.0048	0.78
690	B006	Chromium (Cr)	21.2	mg/kg	0.0029	NA
690	B006	Manganese (Mn)	62.7	mg/kg	0.0009	NA
		Total			0.0087	0.78
690	B007	Arsenic (As)	2.2	mg/kg	0.0051	0.81
690	B007	Benzo(a)pyrene equivalents	858.65	ug/kg	NA	2.89
690	B007	Chromium (Cr)	9.5	mg/kg	0.0013	NA
690	B007	Manganese (Mn)	58.6	mg/kg	0.0009	NA
		Total			0.0072	3.70
690	B008	Arsenic (As)	4.7	mg/kg	0.0108	1.74
690	B008	Chromium (Cr)	11.9	mg/kg	0.0016	NA
690	B008	Copper (Cu)	24.2	mg/kg	0.0004	NA
690	B008	Manganese (Mn)	203	mg/kg	0.0030	NA
		Total			0.0158	1.74
690	B009	Arsenic (As)	3.6	mg/kg	0.0083	1.33
690	B009	Chromium (Cr)	66.2	mg/kg	0.0091	NA

690	B009	Manganese (Mn)	147	mg/kg	0.0022	NA
		Total			0.0196	1.33
690	B010	Arsenic (As)	7.4	mg/kg	0.0170	2.73
690	B010	Benzo(a)pyrene equivalents	317.63	ug/kg	NA	1.07
690	B010	Chromium (Cr)	48	mg/kg	0.0066	NA
690	B010	Copper (Cu)	321	mg/kg	0.0055	NA
690	B010	Manganese (Mn)	135	mg/kg	0.0020	NA
		Total			0.0311	3.80
690	B011	Arsenic (As)	6.7	mg/kg	0.0154	2.48
690	B011	Chromium (Cr)	36.4	mg/kg	0.0050	NA
690	B011	Copper (Cu)	37.1	mg/kg	0.0006	NA
690	B011	Manganese (Mn)	178	mg/kg	0.0026	NA
		Total			0.0237	2.48
690	B012	Arsenic (As)	9.8	mg/kg	0.0225	3.62
690	B012	Benzo(a)pyrene equivalents	78.35	ug/kg	NA	0.26
690	B012	Chromium (Cr)	19.7	mg/kg	0.0027	NA
690	B012	Copper (Cu)	16.1	mg/kg	0.0003	NA
690	B012	Manganese (Mn)	60.4	mg/kg	0.0009	NA
		Total			0.0264	3.88
690	B013	Arsenic (As)	9.2	mg/kg	0.0212	3.40
690	B013	Chromium (Cr)	55.9	mg/kg	0.0077	NA
690	B013	Copper (Cu)	32.5	mg/kg	0.0006	NA
690	B013	Manganese (Mn)	289	mg/kg	0.0042	NA
		Total			0.0337	3.40
690	B014	Arsenic (As)	6.4	mg/kg	0.0147	2.36
690	B014	Benzo(a)pyrene equivalents	57.66	ug/kg	NA	0.19
690	B014	Chromium (Cr)	31.4	mg/kg	0.0043	NA
690	B014	Copper (Cu)	20.4	mg/kg	0.0003	NA
690	B014	Manganese (Mn)	111	mg/kg	0.0016	NA
		Total			0.0210	2.56
690	B015	Arsenic (As)	9.7	mg/kg	0.0223	3.58
690	B015	Benzo(a)pyrene equivalents	74.17	ug/kg	NA	0.25
690	B015	Chromium (Cr)	32.5	mg/kg	0.0045	NA
690	B015	Chromium (Hexavalent)	3.98	mg/kg	0.0005	NA
690	B015	Copper (Cu)	20.25	mg/kg	0.0003	NA
690	B015	Manganese (Mn)	281.5	mg/kg	0.0041	NA
		Total			0.0318	3.83
690	B016	Arsenic (As)	1.9	mg/kg	0.0044	0.70
690	B016	Benzo(a)pyrene equivalents	4.64	ug/kg	NA	0.02
690	B016	Chromium (Cr)	131	mg/kg	0.0181	NA
690	B016	Copper (Cu)	35.8	mg/kg	0.0006	NA
690	B016	Manganese (Mn)	54.4	mg/kg	0.0008	NA
		Total			0.0239	0.72
690	B017	Arsenic (As)	3.6	mg/kg	0.0083	1.33
690	B017	Chromium (Cr)	33.4	mg/kg	0.0046	NA
690	B017	Copper (Cu)	15.2	mg/kg	0.0003	NA
690	B017	Manganese (Mn)	25.8	mg/kg	0.0004	NA
		Total			0.0135	1.33
690	B018	Arsenic (As)	10.7	mg/kg	0.0246	3.95
690	B018	Benzo(a)pyrene equivalents	1788.6	ug/kg	NA	6.02
690	B018	Chromium (Cr)	29.4	mg/kg	0.0041	NA

690	B018	Copper (Cu)	74.4	mg/kg	0.0013	NA
690	B018	Manganese (Mn)	76.3	mg/kg	0.0011	NA
		Total			0.0311	9.98
690	B019	Arsenic (As)	1.3	mg/kg	0.0030	0.48
690	B019	Benzo(a)pyrene equivalents	5.98	ug/kg	NA	0.02
690	B019	Chromium (Cr)	42.7	mg/kg	0.0059	NA
690	B019	Copper (Cu)	90.7	mg/kg	0.0016	NA
690	B019	Manganese (Mn)	82.2	mg/kg	0.0012	NA
		Total			0.0116	0.50
690	B020	Arsenic (As)	11.8	mg/kg	0.0271	4.36
690	B020	Benzo(a)pyrene equivalents	60.98	ug/kg	NA	0.21
690	B020	Chromium (Cr)	26.5	mg/kg	0.0037	NA
690	B020	Copper (Cu)	18.5	mg/kg	0.0003	NA
690	B020	Manganese (Mn)	77.5	mg/kg	0.0011	NA
		Total			0.0322	4.57
690	B021	Arsenic (As)	6.7	mg/kg	0.0154	2.48
690	B021	Benzo(a)pyrene equivalents	7.57	ug/kg	NA	0.03
690	B021	Chromium (Cr)	19.3	mg/kg	0.0027	NA
690	B021	Copper (Cu)	23	mg/kg	0.0004	NA
690	B021	Manganese (Mn)	113	mg/kg	0.0017	NA
		Total			0.0201	2.50
690	B022	Benzo(a)pyrene equivalents	0.39	ug/kg	NA	0.001
690	B022	Chromium (Cr)	6.5	mg/kg	0.0009	NA
690	B022	Antimony (Sb)	0.28	mg/kg	0.0005	NA
690	B022	Copper (Cu)	2.1	mg/kg	0.0000	NA
690	B022	Manganese (Mn)	14	mg/kg	0.0002	NA
		Total			0.0016	0.001
690	B023	Arsenic (As)	7.9	mg/kg	0.0182	2.92
690	B023	Chromium (Cr)	21.8	mg/kg	0.0030	NA
690	B023	Copper (Cu)	9.3	mg/kg	0.0002	NA
690	B023	Manganese (Mn)	150	mg/kg	0.0022	NA
		Total			0.0235	2.92
690	B024	Chromium (Cr)	4.1	mg/kg	0.0006	NA
690	B024	Copper (Cu)	0.72	mg/kg	0.0000	NA
690	B024	Manganese (Mn)	8.7	mg/kg	0.0001	NA
		Total			0.0007	NA
690	B025	Arsenic (As)	2.6	mg/kg	0.0060	0.96
690	B025	Chromium (Cr)	10.3	mg/kg	0.0014	NA
690	B025	Copper (Cu)	16.7	mg/kg	0.0003	NA
690	B025	Manganese (Mn)	83.2	mg/kg	0.0012	NA
		Total			0.0089	0.96
690	B026	Arsenic (As)	5.5	mg/kg	0.0126	2.03
690	B026	Chromium (Cr)	57.6	mg/kg	0.0079	NA
690	B026	Chromium (Hexavalent)	0.512	mg/kg	0.0001	NA
690	B026	Copper (Cu)	17.3	mg/kg	0.0003	NA
690	B026	Manganese (Mn)	54.2	mg/kg	0.0008	NA
		Total			0.0218	2.03
690	B027	Arsenic (As)	8.2	mg/kg	0.0189	3.03
690	B027	Chromium (Cr)	38.1	mg/kg	0.0053	NA
690	B027	Copper (Cu)	25.2	mg/kg	0.0004	NA
690	B027	Manganese (Mn)	196	mg/kg	0.0029	NA

		Total			0.0274	3.03
690	B028	Arsenic (As)	7	mg/kg	0.0161	2.59
690	B028	Chromium (Cr)	27.6	mg/kg	0.0038	NA
690	B028	Copper (Cu)	14	mg/kg	0.0002	NA
690	B028	Manganese (Mn)	125	mg/kg	0.0018	NA
		Total			0.0220	2.59
690	B029	Arsenic (As)	28.7	mg/kg	0.0660	10.60
690	B029	Benzo(a)pyrene equivalents	24.57	ug/kg	NA	0.35
690	B029	Chromium (Cr)	19.3	mg/kg	0.0027	NA
690	B029	Copper (Cu)	22.3	mg/kg	0.0004	NA
690	B029	Manganese (Mn)	172	mg/kg	0.0025	NA
		Total			0.0716	10.95
690	B030	Arsenic (As)	5.3	mg/kg	0.0122	1.96
690	B030	Chromium (Cr)	21.2	mg/kg	0.0029	NA
690	B030	Copper (Cu)	12.6	mg/kg	0.0002	NA
690	B030	Manganese (Mn)	142	mg/kg	0.0021	NA
		Total			0.0174	1.96
690	B031	Benzo(a)pyrene equivalents	743.76	ug/kg	NA	2.50
690	B032	Benzo(a)pyrene equivalents	364.99	ug/kg	NA	1.23
690	B034	Arsenic (As)	10	mg/kg	0.0230	3.70
690	B034	Antimony (Sb)	24.5	mg/kg	0.0422	NA
690	B034	Chromium (Cr)	58.7	mg/kg	0.0081	NA
690	B034	Copper (Cu)	123	mg/kg	0.0021	NA
690	B034	Manganese (Mn)	112	mg/kg	0.0016	NA
		Total			0.0771	3.70
690	B035	Arsenic (As)	7.5	mg/kg	0.0172	2.77
690	B035	Chromium (Cr)	45.4	mg/kg	0.0063	NA
690	B035	Copper (Cu)	37.4	mg/kg	0.0006	NA
690	B035	Manganese (Mn)	106	mg/kg	0.0016	NA
		Total			0.0257	2.77
690	B036	Arsenic (As)	10.9	mg/kg	0.0251	4.03
690	B036	Chromium (Cr)	43.7	mg/kg	0.0060	NA
690	B036	Copper (Cu)	20.8	mg/kg	0.0004	NA
690	B036	Manganese (Mn)	461	mg/kg	0.0068	NA
		Total			0.0382	4.03
690	B037	Arsenic (As)	3.35	mg/kg	0.0077	1.24
690	B037	Antimony (Sb)	0.46	mg/kg	0.0008	NA
690	B037	Chromium (Cr)	26.85	mg/kg	0.0037	NA
690	B037	Copper (Cu)	8.85	mg/kg	0.0002	NA
690	B037	Manganese (Mn)	268	mg/kg	0.0039	NA
		Total			0.0163	1.24
690	B038	Arsenic (As)	1.5	mg/kg	0.0034	0.55
690	B038	Chromium (Cr)	14.3	mg/kg	0.0020	NA
690	B038	Copper (Cu)	12.7	mg/kg	0.0002	NA
690	B038	Manganese (Mn)	42.9	mg/kg	0.0006	NA
		Total			0.0063	0.55
690	B039	Arsenic (As)	1.5	mg/kg	0.0034	0.55
690	B039	Antimony (Sb)	0.57	mg/kg	0.0010	NA
690	B039	Chromium (Cr)	13.9	mg/kg	0.0019	NA

690	B039	Copper (Cu)	15.2	mg/kg	0.0003	NA
690	B039	Manganese (Mn)	26	mg/kg	0.0004	NA
		Total			0.0070	0.55
690	B040	Arsenic (As)	3.7	mg/kg	0.0085	1.37
690	B040	Chromium (Cr)	28.3	mg/kg	0.0039	NA
690	B040	Copper (Cu)	28.1	mg/kg	0.0005	NA
690	B040	Manganese (Mn)	152	mg/kg	0.0022	NA
		Total			0.0151	1.37
690	B041	Arsenic (As)	2.3	mg/kg	0.0053	0.85
690	B041	Chromium (Cr)	10.4	mg/kg	0.0014	NA
690	B041	Copper (Cu)	15.8	mg/kg	0.0003	NA
690	B041	Manganese (Mn)	36.8	mg/kg	0.0005	NA
		Total			0.0075	0.85
690	B042	Arsenic (As)	2.8	mg/kg	0.0064	1.03
690	B042	Benzo(a)pyrene equivalents	245.23	ug/kg	NA	0.83
690	B042	Chromium (Cr)	40	mg/kg	0.0055	NA
690	B042	Copper (Cu)	305	mg/kg	0.0052	NA
690	B042	Manganese (Mn)	125	mg/kg	0.0018	NA
		Total			0.0190	1.86

Table 10.10.19
Remedial Goal Options for Surface Soil
AOCs 689 and 690
Charleston Naval Complex
Charleston, South Carolina

Resident-Based Remedial Goal Options*

Chemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	EPC mg/kg	Hazard-Based Remedial Goal Options 3 mg/kg	1 mg/kg	0.1 mg/kg	Risk-Based Remedial Goal Options 1E-06 mg/kg	1E-05 mg/kg	1E-04 mg/kg	Background Concentration mg/kg
Benzo(a)pyrene Equivalents	7.3	NA	0.79	ND	ND	ND	0.12	1.2	12	ND
Arsenic	1.5	0.0003	11.9	66	22	2.2	0.38	3.8	38	21.6
4-Aminobiphenyl	230	0.003	0.06	5457	1819	182	0.019	0.19	1.9	ND

Worker-Based Remedial Goal Options

Chemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	EPC mg/kg	Hazard-Based Remedial Goal Options 3 mg/kg	1 mg/kg	0.1 mg/kg	Risk-Based Remedial Goal Options 1E-06 mg/kg	1E-05 mg/kg	1E-04 mg/kg	Background Concentration mg/kg
Arsenic	1.5	0.0003	11.9	27029	9010	901	2.71	27.1	271	21.6

Notes:
EPC exposure point concentration
NA not applicable
ND not determined
* remedial goal options were calculated based on the resident lifetime-weighted average for carcinogens and the child resident for noncarcinogens

Table 10.10.20
AOC 689/690
Cumulative and Chemical-Specific Exposure Risks and Hazard

Chemical	Risk: Industrial	Risk: Residential	Hazard: Industrial	Hazard: Residential
Soil				
Arsenic	4.4E-6	3.11E-5	0.027	0.55
BEQs	1.33E-6	6.5E-6	ND	ND
Chromium	ND	ND	0.0061	0.12
Copper	ND	ND	0.0013	0.026
4-Aminobiphenyl	6.4E-7	9.7E-6	0.000003	0.000033
Cumulative	6.37E-6	4.7E-5	0.034	0.15

Note:
ND = Not detected

Table 10.10.21
AOC 689/690
Potential Corrective Measures

Medium	Compounds	Potential Corrective Measures
Soil	Arsenic, BEQs, Chromium, Copper, 4-Aminobiphenyl	a) No action b) Excavate, offsite disposal, and monitoring c) Containment/capping

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10.11 SWMU 12, Old Firefighter Training Area

SWMU 12 is the former firefighter training area located in the southwestern portion of the southern peninsula. At this SWMU, flammable liquids were pumped into a shallow 30- to 50-foot diameter pit, ignited, and then extinguished with water. Training occurred between 1966 and 1971; the frequency of training and types of flammable liquids used are not documented. A gravel road and clearing at the SWMU, currently used infrequently as a construction laydown yard, are reportedly near the former training area's location.

Materials of concern include petroleum hydrocarbons, coal ash, SVOCs, and metals. Potential receptors include workers who perform invasive and non-invasive activities at the site. Shipyard Creek and terrestrial ecological areas are also potential receptors.

To fulfill RFI objectives, soil and groundwater were sampled in accordance with the approved final RFI work plan and Section 3 of this report. Sampling was conducted to evaluate the presence of any contamination resulting from past activities at the site.

10.11.1 Soil Sampling and Analysis

Soil was sampled in two rounds at SWMU 12 at the locations shown on Figure 10.11.1. The approved final RFI work plan proposed collection of 13 soil samples from the upper-interval and 13 from the lower-interval. During the first-round of sampling, 12 upper-interval samples were collected and analyzed for the standard suite (VOCs, SVOCs, metals, cyanide, pesticides, and PCBs) and organotins at DQO Level III. One proposed sample location was inaccessible because of construction materials in the laydown yard. No lower-interval samples were collected because the water table was at less than 5 feet bgs. Two samples were collected as duplicates and submitted for Appendix IX analysis, which includes the standard suite plus herbicides, hex-chrome, OP pesticides, and dioxins.

Second-round sampling was performed following comparison of first-round analytical results to the USEPA Region III *Risk-Based Concentration Table*, April 1998 and to further delineate the extent of dioxins at the site. A review of the preliminary (unvalidated) data indicated the presence of PAHs above RBCs in the vicinity of 012SB001 and 012SB002. Three additional samples were collected in this vicinity and analyzed for SVOCs at DQO Level III. Three samples were collected for dioxins in December 1998 in the vicinity of soil borings 012SB001 and 012SB010.Table 10.11.1 summarizes the first and second-round of soil sampling.

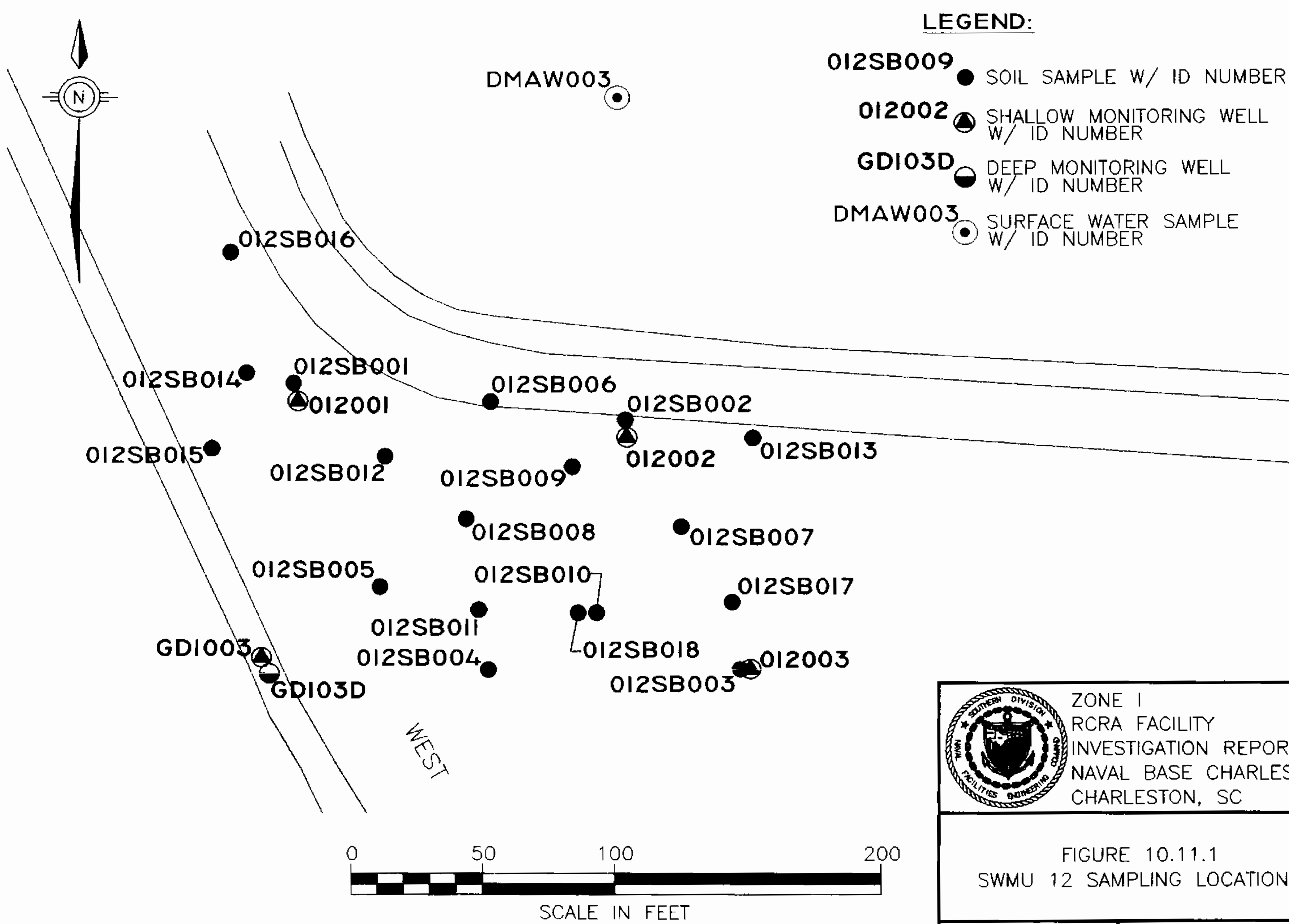
Table 10.11.1
SWMU 12
Soil Sampling Summary

Sampling Round	Sampling Dates	Samples Collected	Sample Analyses	Comments
1	03/08/95 03/09/95	Upper - 12 (13)	Standard Suite, Organotins, Physical Parameters	One sample location was inaccessible. Lower samples were not collected due to a water table at less than 5 feet bgs.
		Lower - 0 (13)	NA	
		Duplicate - 2	Appendix IX	
2	06/20/95	Upper - 3	SVOCs	Samples were collected to delineate the potential extent of PAHs.
3	12/10/98	Upper - 3	Dioxins	Dioxin samples were collected in Dec. 1998 to further delineate the extent of dioxin at the site.
		Lower - 3	Dioxins	
		Duplicate - 1	Dioxins	

Notes:
NA = Not Applicable
( ) = Parenthesis indicate number of samples proposed in RFI work plan.
Standard Suite = VOCs, SVOCs, metals, cyanide, pesticides, and PCBs at DQO Level III.
Appendix IX = Standard Suite, plus hex-chrome, dioxins, herbicides, pesticides at DQO Level IV.
Physical parameters analysis included CEC, chloride, sulfur, ammonia, nitrate/nitrite, phosphorus, TOC, and total moisture.

10.11.2 Nature and Extent of Contamination in Soil

Organic compound analytical data for soil are summarized in Table 10.11.2. Inorganic compound analytical data are presented in Table 10.11.3. Table 10.11.4 summarizes analytes detected in surface soil at SWMU 12. Appendix D contains the complete analytical data report for all samples collected in Zone I, including those from SWMU 12.



ZONE I
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.11.1
SWMU 12 SAMPLING LOCATIONS

Date: 05/26/99 | DWG Name: 2909C023

Volatile Organic Compounds in Soil

Three VOCs – acetone, 2-Butanone, and toluene – were detected in SWMU 12 upper-interval soil samples. None was detected above the respective RBC.

Semivolatile Organic Compounds in Soil

Eight SVOCs were detected in soil samples collected at SWMU 12. Of these, only benzo(a)pyrene (100 μg/kg) was detected at a concentration that exceeded its RBC. The upper-interval sample collected at 012SB014 was the only sample that contained benzo(a)pyrene.

In accordance with recent cPAH guidance (USEPA *Interim Supplemental Guidance to RAGS: Region IV Bulletins, Human Health Risk Assessment,* Bulletin No. 2 [USEPA 1995a]) and Section 7 of this report, BEQs were calculated for cPAHs at SWMU 12. The maximum BEQ, and the only one to exceed the RBC of 87 μg/kg, was calculated at 147 μg/kg for sample 012SB01401.

Pesticides and PCBs in Soil

Seven pesticides were detected at SWMU 12, all far below the respective RBCs. No PCBs were detected.

Table 10.11.2
SWMU 12
Organic Compound Analytical Results for Surface and Subsurface Soil (μg/kg)

Parameter	Sample Interval	Detection Frequency	Detection Range	Mean	RBC (upper) SSL (lower)	Number of Samples Exceeding RBC
Volatile Organic Compounds						
Acetone	Upper	9/12	9.0 - 67.0	34.2	780,000	0
2-Butanone	Upper	2/12	11.0 - 13.0	12.0	4,700,000	0
Toluene	Upper	9/12	2.0 - 27.0	8.8	1,600,000	0
Semivolatile Organic Compounds						
BEQ	Upper	4/15	0.08 - 147	40.7	87	1
Benzo(a)anthracene	Upper	2/15	60.0 - 67.0	63.5	870	0
Benzo(a)pyrene	Upper	1/15	100	100	87	1
Benzo(b)fluoranthene	Upper	2/15	90.0 - 360	225	870	0
Benzo(k)fluoranthene	Upper	2/15	110 - 390	250	8,700	0

Table 10.11.2
SWMU 12
Organic Compound Analytical Results for Surface and Subsurface Soil (μg/kg)

Parameter	Sample Interval	Detection Frequency	Detection Range	Mean	RBC (upper) SSL (lower)	Number of Samples Exceeding RBC
Chrysene	Upper	3/15	65.0 - 130.0	93.0	87,00	0
Fluoranthene	Upper	3/15	76.0 - 81.0	78.7	310,000	0
Pyrene	Upper	3/15	60.0 - 180	100	230,000	0
bis(2-ethylhexyl)phthalate	Upper	2/15	62.0 - 2,400	1,231	46,000	0
Pesticides & PCBs						
Endosulfan II	Upper	1/12	6.55	6.55	47,000	0
Endrin aldehyde	Upper	3/12	1.7 - 3.6	2.5	2,300	0
Heptachlor epoxide	Upper	1/12	4.3	4.3	70	0
4,4'-DDE	Upper	1/12	0.64	0.64	1,900	0
4,4'-DDT	Upper	1/12	1.3	1.3	1,900	0
Methoxychlor	Upper	1/12	1.3	1.3	39,000	0
beta-BHC	Upper	1/12	8.0	8.0	350	0
Organotin Compounds						
Tetrabutyltin	Upper	2/12	198 - 316	257	2,300	0
Dioxin Compounds						
TEQs	Upper Lower	5/5 3/3	2.55E-04 -3.15E-03 4.7E-03-4.39E-02	9.66E-04 1.82E-02	4.3E-03 1600	0
1234678-HpCDD	Upper Lower	5/5 3/3	1.13E-02 - 7.30E-02 4.9E-04-3.46E-03	2.43E-02 3.47E-04	0.43 108000	0
123478-HxCDD	Upper	2/5	5.19E-04 - 2.59E-04	3.89E-04	0.043	0
123678-HxCDD	Upper	3/5	3.79E-04 - 2.42E-03	1.07E-03	0.043	0
123789-HxCDD	Upper	3/5	3.27E-04 - 3.89E-03	1.66E-03	0.043	0
1234678-HpCDF	Upper	5/5	1.99E-03 - 2.11E-03	2.05E-03	0.43	0
2378-TCDF	Upper	1/5	5.12E-04	5.12E-04	0.043	0
12378-PeCDF	Upper	1/5	3.11E-04	3.11E-04	0.086	0
23478-PeCDF	Upper	2/5	2.94E-04 - 9.59E-04	6.27E-04	8.6E-03	0
123478-HxCDF	Upper Lower	3/5 2/3	6.22E-04 - 2.21E-03 1.22E-04-1.82E-04	1.19E-03 1.52E-04	0.043 216	0
123678-HxCDF	Upper	1/5	7.64E-04	7.64E-04	0.043	0
OCDD	Upper Lower	5/5 3/3	0.118 - 0.859 4.15E-03-3.93E-02	0.283 1.63E-02	4.3 1080	0
OCDF	Upper Lower	5/5 1/3	2.29E-03 - 2.18E-02 9.67E-04	7.67E-03 9.67E-04	4.3 540	0

Notes:
μg/kg = micrograms per kilogram
RBC = Risk-based concentration
See Table 5.5 for organic compound screening concentrations and their sources.

Table 10.11.3
SWMU 12
Inorganic Compounds Analytical Results for Surface Soil (mg/kg)

Parameter	Sample Interval	Detection Frequency	Detection Range	Mean	Background Concentration	RBC (upper)	Number of Samples Exceeding: RBC & Background
Aluminum (Al)	Upper	12/12	3,020 - 17,900	8,009	27400	7,800	0
Antimony (Sb)	Upper	8/12	0.29 - 0.49	0.37	ND	3.1	0
Arsenic (As)	Upper	12/12	3.7 - 14.2	7.5	21.6	0.43	0
Barium (Ba)	Upper	12/12	5.4 - 27.3	15.2	54.2	550	0
Beryllium (Be)	Upper	12/12	0.2 - 0.63	0.35	0.95	16	0
Cadmium (Cd)	Upper	12/12	0.21 - 0.46	0.35	0.61	7.8	0
Calcium (Cd)	Upper	12/12	39,400 - 164,000	115,800	NL	NL	NA
Chromium (Cr) (Total)	Upper	12/12	23.9 - 39.0	30.9	34.5	39	0
Chromium (Cr_6) (Hexavalent)	Upper	1/2	0.415	0.415	ND	39	0
Cobalt (Co)	Upper	11/12	0.72 - 3.7	1.8	5.8	470	0
Copper (Cu)	Upper	12/12	10.6 - 27.7	15.2	240	310	0
Iron (Fe)	Upper	12/12	3,040 - 14,900	6,512	NL	NL	NA
Lead (Pb)	Upper	12/12	1.8 - 19.3	7.95	203	400	0
Magnesium (Mg)	Upper	12/12	2,710 - 6,140	3,527	NL	NL	NA
Manganese (Mn)	Upper	11/12	38.4 - 286	118	419	160	0
Mercury (Hg)	Upper	1/12	0.24	0.24	0.47	2.3	0
Nickel (Ni)	Upper	12/12	12.4 - 17.0	14.6	23.9	160	0
Potassium (K)	Upper	12/12	728 - 1,630	1,144	NL	NL	NA
Selenium (Se)	Upper	12/12	0.99 - 1.8	1.4	1.49	39	0
Sodium (Na)	Upper	12/12	550 - 2,140	1,431	NL	NL	NA
Tin (Sn)	Upper	1/12	1.4	1.4	7.5	4,700	0

Table 10.11.3
SWMU 12
Inorganic Compounds Analytical Results for Surface Soil (mg/kg)

Parameter	Sample Interval	Detection Frequency	Detection Range	Mean	Background Concentration	RBC (upper)	Number of Samples Exceeding: RBC & Background
Vanadium (V)	Upper	12/12	12.9 - 34.9	21.0	113	55	0
Zinc (Zn)	Upper	12/12	23.5 - 54.6	40.0	206	2,300	0

Notes:
NL = Not Listed
NA = Not Applicable
ND = Not Detected/Not Determined
mg/kg = milligrams per kilogram
RBC = Risk-based concentration
See Table 5.6 for inorganic screening concentrations and their sources.

Table 10.11.4
SWMU 12
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Volatile Organic Compounds (µg/kg)							
Acetone	012SB001	39.5	780000	NA	NT	8000	NA
	012SB002	60			NT		
	012SB003	15			NT		
	012SB007	12			NT		
	012SB008	45			NT		
	012SB009	47			NT		
	012SB010	9			NT		
	012SB011	13			NT		
	012SB012	67			NT		
2-Butanone (MEK)	012SB008	13	4700000	NA	NT	3900	NA
	012SB012	11			NT		
Toluene	012SB001	10	1600000	NA	NT	6000	NA
	012SB003	10			NT		
	012SB004	2			NT		
	012SB007	5			NT		
	012SB008	5			NT		
	012SB009	10			NT		
	012SB010	8.5			NT		
	012SB011	2			NT		
	012SB012	27			NT		

Table 10.11.4
SWMU 12
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Semivolatile Organic Compounds (µg/kg)							
Benzo(a)pyrene Equivalents (BEQs)	012SB002	10.1	87	NA	NT	1600	NA
	012SB006	0.084			NT		
	012SB007	6.065			NT		
	012SB014	147			NT		
Benzo(a)anthracene	012SB007	60	870	NA	NT	800	NA
	012SB014	67			NT		
Benzo(a)pyrene	012SB014	100	87	NA	NT	4000	NA
Benzo(b)fluoranthene	012SB002	90	870	NA	NT	2500	NA
	012SB014	360			NT		
Benzo(k)fluoranthene	012SB002	110	8700	NA	NT	25000	NA
	012SB014	390			NT		
Chrysene	012SB006	84	87000	NA	NT	80000	NA
	012SB007	65			NT		
	012SB014	130			NT		
bis(2-Ethylhexyl)phthalate	012SB013	62	46000	NA	NT	1800000	NA
(BEHP)	012SB014	2400			NT		
Fluoranthene	012SB006	79	310000	NA	NT	2100000	NA
	012SB007	76			NT		
	012SB014	81			NT		
Pyrene	012SB006	60	230000	NA	NT	2100000	NA
	012SB007	60			NT		
	012SB014	180			NT		

Table 10.11.4
SWMU 12
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Pesticides/PCBs (µg/kg)							
beta-BHC (beta-HCH)	012SB008	8	350	NA	NT	1.3	NA
4,4'-DDE	012SB010	0.64	1900	NA	NT	27000	NA
4,4'-DDT	012SB010	1.3	1900	NA	NT	16000	NA
Endosulfan II	012SB010	6.55	47000	NA	NT	9000	NA
Endrin aldehyde	012SB002	1.7	2300	NA	NT	340	NA
	012SB007	3.6			NT		
	012SB010	2.25			NT		
Heptachlor epoxide	012SB006	4.3	70	NA	NT	330	NA
Methoxychlor	012SB010	1.3	39000	NA	NT	80000	NA
Organotin (µg/kg)							
Tetrabutyltin	012SB001	197.9	2300	NA	NT	NA	NA
	012SB012	316.23			NT		
Dioxin Compounds (ng/kg)							
2,3,7,8-TCDD equivalents (TEQs)	012SB001	0.337	4.3	NA	NT	1600	NA
	012SB010	0.255			NT		
	012SB016	3.148			43.909		
	012SB017	0.637			6.002		
	012SB018	0.451			4.701		
1234678-HpCDD	012SB001	12.936	430	NA	NT	108000	NA
	012SB010	11.299			NT		
	012SB016	73.05			3.46		
	012SB017	12.3			0.49		
	012SB018	12.1			0.551		

Table 10.11.4
SWMU 12
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
123478-HxCDD	012SB016	0.519		NA	ND		NA
	012SB017	0.259			ND		NA
123678-HxCDD	012SB016	2.42	43	NA	ND	4100	
	012SB017	0.379			ND		
	012SB018	0.412			ND		
123789-HxCDD	012SB016	3.89	43	NA	ND	4100	NA
	012SB017	0.773			ND		
	012SB018	0.327			ND		
OCDD	012SB001	182.43	4300	NA	NT	1080000	NA
	012SB010	117.695			NT		
	012SB016	859			39.3		
	012SB017	139			5.39		
	012SB018	119			4.15		
2378-TCDF	012SB018	0.512		NA	ND		NA
12378-PeCDF	012SB016	0.311			ND		
23478-PeCDF	012SB016	0.959		NA	ND		NA
	012SB017	0.294			ND		
123478-HxCDF	012SB016	2.21		NA	0.182		NA
	012SB017	0.763			0.122		
	012SB018	0.622			ND		
123678-HxCDF	012SB016	0.764	43	NA	ND	216000	NA
1234678-HpCDF	012SB001	2.112	430	NA	NT	54000	NA
	012SB010	1.985			NT		
	012SB016	6.14			ND		
	012SB017	0.83			ND		
	012SB018	1.8			ND		

Table 10.11.4
SWMU 12
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
OCDF	012SB001	3.985	4300	NA	NT	540000	NA
	012SB010	4.729			NT		
	012SB016	21.75			0.967		
	012SB017	2.29			ND		
	012SB018	5.63			ND		
Inorganics (mg/kg)							
Aluminum (Al)	012SB001	8940	7800	27400	NT	560000	18900
	012SB002	15600			NT		
	012SB003	7740			NT		
	012SB004	7550			NT		
	012SB005	3200			NT		
	012SB006	17900			NT		
	012SB007	3020			NT		
	012SB008	6650			NT		
	012SB009	8200			NT		
	012SB010	6180			NT		
	012SB011	3310			NT		
	012SB012	7820			NT		
Antimony (Sb)	012SB001	0.37	3.1	ND	NT	2.7	ND
	012SB003	0.38			NT		
	012SB005	0.36			NT		
	012SB007	0.33			NT		
	012SB008	0.4			NT		

Table 10.11.4
SWMU 12
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Antimony (Sb) (Continued)	012SB009	0.34			NT		
	012SB010	0.29			NT		
	012SB011	0.49			NT		
Arsenic (As)	012SB001	6.9	0.43	21.6	NT	15	6.45
	012SB002	14.2			NT		
	012SB003	12.9			NT		
	012SB004	3.7			NT		
	012SB005	4.9			NT		
	012SB006	8.8			NT		
	012SB007	6.3			NT		
	012SB008	7.9			NT		
	012SB009	7.9			NT		
	012SB010	6.25			NT		
	012SB011	4.8			NT		
	012SB012	5.8			NT		
Barium (Ba)	012SB001	11.8	550	54.2	NT	820	36
	012SB002	24.1			NT		
	012SB003	12.7			NT		
	012SB004	12.2			NT		
	012SB005	5.4			NT		
	012SB006	27.3			NT		
	012SB007	17.4			NT		
	012SB008	13.8			NT		
	012SB009	18.1			NT		

Table 10.11.4
SWMU 12
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Barium (Ba) (Continued)	012SB010	9.8			NT		
	012SB011	6			NT		
	012SB012	24.2			NT		
Beryllium (Be)	012SB001	0.355	16	0.95	NT	32	0.67
	012SB002	0.61			NT		
	012SB003	0.34			NT		
	012SB004	0.2			NT		
	012SB005	0.22			NT		
	012SB006	0.63			NT		
	012SB007	0.28			NT		
	012SB008	0.29			NT		
	012SB009	0.4			NT		
	012SB010	0.285			NT		
	012SB011	0.23			NT		
	012SB012	0.36			NT		
Cadmium (Cd)	012SB001	0.365	7.8	0.61	NT	4	0.54
	012SB002	0.36			NT		
	012SB003	0.46			NT		
	012SB004	0.36			NT		
	012SB005	0.25			NT		
	012SB006	0.44			NT		
	012SB007	0.21			NT		
	012SB008	0.34			NT		
	012SB009	0.36			NT		

Table 10.11.4
SWMU 12
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Cadmium (Cd) (Continued)	012SB010	0.425			NT		
	012SB011	0.32			NT		
	012SB012	0.29			NT		
Chromium (Cr) (total)	012SB001	28.9	39	34.5	NT	19	51.3
	012SB002	33.5			NT		
	012SB003	33.6			NT		
	012SB004	29.6			NT		
	012SB005	25.6			NT		
	012SB006	37.6			NT		
	012SB007	23.9			NT		
	012SB008	27.5			NT		
	012SB009	39			NT		
	012SB010	32.8			NT		
	012SB011	31			NT		
	012SB012	27.8			NT		
Chromium (Cr6) (hexavalent)	012SB010	0.01	39	ND	NT	19	ND
Cobalt (Co)	012SB001	1.6	470	5.8	NT	990	3.48
	012SB002	3.5			NT		
	012SB003	1.5			NT		
	012SB004	1.1			NT		
	012SB006	3.7			NT		
	012SB007	1			NT		
	012SB008	1.4			NT		
	012SB009	1.9			NT		

Table 10.11.4
SWMU 12
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Cobalt (Co) (Continued)	012SB010	1.25			NT		
	012SB011	0.72			NT		
	012SB012	2			NT		
Copper (Cu)	012SB001	14.95	310	240	NT	5600	11.5
	012SB002	16.6			NT		
	012SB003	11.1			NT		
	012SB004	12.6			NT		
	012SB005	10.6			NT		
	012SB006	17			NT		
	012SB007	13.7			NT		
	012SB008	15			NT		
	012SB009	27.7			NT		
	012SB010	13.7			NT		
	012SB011	16.4			NT		
	012SB012	12.9			NT		
Lead (Pb)	012SB001	6.3	400	203	NT	400	12.3
	012SB002	19.3			NT		
	012SB003	4.9			NT		
	012SB004	7.7			NT		
	012SB005	1.8			NT		
	012SB006	15.9			NT		
	012SB007	3.1			NT		
	012SB008	6.7			NT		

Table 10.11.4
SWMU 12
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Lead (Pb) (Continued)	012SB009	9.8			NT		
	012SB010	6.5			NT		
	012SB011	6.4			NT		
	012SB012	7			NT		
Manganese (Mn)	012SB001	119	160	419	NT	480	118
	012SB002	209			NT		
	012SB003	62.2			NT		
	012SB004	44.8			NT		
	012SB006	286			NT		
	012SB007	38.4			NT		
	012SB008	202			NT		
	012SB009	102			NT		
	012SB010	74.45			NT		
	012SB011	40			NT		
	012SB012	125			NT		
Mercury (Hg)	012SB001	0.24	2.3	0.47	NT	1	ND
Nickel (Ni)	012SB001	14.4	160	23.9	NT	65	15.7
	012SB002	12.5			NT		
	012SB003	15.9			NT		
	012SB004	12.4			NT		
	012SB005	14.4			NT		
	012SB006	13.8			NT		
	012SB007	13.1			NT		
	012SB008	13.9			NT		

Table 10.11.4
SWMU 12
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Nickel (Ni) (Continued)	012SB009	17			NT		
	012SB010	16.7			NT		
	012SB011	16.3			NT		
	012SB012	14.4			NT		
Selenium (Se)	012SB001	1.7	39	1.49	NT	2.6	1.77
	012SB002	1.2			NT		
	012SB003	1.6			NT		
	012SB004	1.1			NT		
	012SB005	1.6			NT		
	012SB006	1.4			NT		
	012SB007	1.5			NT		
	012SB008	1.2			NT		
	012SB009	1.5			NT		
	012SB010	1.6			NT		
	012SB011	1.8			NT		
	012SB012	0.99			NT		
Tin (Sn)	012SB009	1.4	4700	7.5	NT	5500	ND

Table 10.11.4
SWMU 12
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Vanadium (V)	012SB001	19.05	55	113	NT	3000	38.1
	012SB002	33.4			NT		
	012SB003	22.1			NT		
	012SB004	19.6			NT		
	012SB005	13.7			NT		
	012SB006	34.9			NT		
	012SB007	12.9			NT		
	012SB008	17.4			NT		
	012SB009	23			NT		
	012SB010	19.9			NT		
	012SB011	17.1			NT		
	012SB012	19.4			NT		
Zinc (Zn)	012SB001	34	2300	206	NT	6200	36.2
	012SB002	53.9			NT		
	012SB003	38.2			NT		
	012SB004	41.3			NT		
	012SB005	25.4			NT		
	012SB006	54.6			NT		
	012SB007	23.5			NT		
	012SB008	37.1			NT		

Table 10.11.4
SWMU 12
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Zinc (Zn) (Continued)	012SB009	51.2			NT		
	012SB010	41			NT		
	012SB011	38.5			NT		
	012SB012	41.7			NT		

Notes:

* = Residential RBCs (THQ=0.1) were used as a reference concentration for upper-interval samples. Generic soil-to groundwater SSLs (DAF=10) from *Soil Screening Guidance: Technical Background Document* (USEPA, 1996b) were used as a reference concentration for lower-interval samples

Bold concentrations exceed both the RBC and the zone background.
All background values for Zone I are based on twice the means of the grid sample concentrations.

NA = Not applicable/not available
ND = Not detected
NT = Not taken
RBC = Risk-based concentration
SSL = Soil screening level
ng/kg = Nanograms per kilogram
μG/KG = Micrograms per kilogram
THQ = Target Hazard Quotient
DAF = Dilution Attenuation Factor

Other Organic Compounds in Soil

Tetrabutyltin was detected in sample 012SB01201 at 316.2 μg/kg; however, this detection did not exceed the RBC.

Dioxins and dibenzofurans were detected in 012SB00101, 012SB01001, 012SB01601, 012SB01701, and 012SB01801 at SWMU 12. In accordance with recent dioxin guidance (USEPA *Interim Supplemental Guidance to RAGS: Region IV Bulletins Human Health Risk Assessment*, Bulletin No. 2 [USEPA 1995a]), and Section 7 of this report, the TEQs were calculated as 3.37E-04 μg/kg, 2.55E-04 μg/kg, 3.14E-03, 6.37E-04, and 4.51E-04 for samples 012SB00101, 012SB01001, 012SB01601, 012SB01701, and 012SB01801 respectively. These TEQs are below the RBC of 4.3E-3 μg/kg for 2,3,7,8-TCDD.

Inorganics in Soil

Twenty-three metals were detected in surface soil samples. No metal concentration exceeded the respective RBC.

The original SWMU 12 RFI, submitted in January 1996, has been updated to include results from more recent sampling efforts. This document (revised and submitted in March 1999) represents "Revision 0" of the original January 1996 RFI.

No changes to extent of contamination definition were identified through the additional soil sample collection and analysis; therefore no changes to the January 1996 version of the SWMU 12 RFI Report Fate and Transport, Human Health Risk Assessment, and Conclusion sections or the Zone I Ecological Risk Assessment section were made.

10.11.3 Groundwater Sampling and Analysis

To characterize groundwater quality at SWMU 12, three shallow monitoring wells were installed and sampled in accordance with the approved final RFI work plan. Table 10.11.5 summarizes the groundwater sampling and analysis and Figure 10.11.1 shows monitoring well locations. The wells were sampled in the first-round for VOCs, SVOCs, metals, cyanide, pesticides, PCBs, organotins, hex-chrome, OP pesticides, dioxins, chlorides, TDS, and sulfates at DQO Level III. Second- and third-round samples from all wells were analyzed for cyanide, metals, chloride, sulfate, and TDS. Samples from one well were also analyzed for chloride, sulfate, and TDS. Fourth-round samples from all wells were analyzed for the standard suite plus chlorides, TDS, sulfates, and dioxins.

Table 10.11.5
SWMU 12
Groundwater Sampling Summary

Sampling Round	Sampling Date	Number of Wells	Sample Analyses	Comments
1	06/08/95 06/12/95	3	Standard Suite, organotins, chloride, TDS, sulfate, herbicides, hex-chrome, OP pesticides, dioxins	Additional samples were collected for site characterization.
2	01/16/96	3	Chloride, cyanide, sulfate, metals, pesticides, PCBs, TDS	1 well (012001) was analyzed for chloride, sulfate, and TDS.
3	05/31/96 06/03/96	3	Chloride, cyanide, sulfate, metals, pesticides, PCBs, TDS	1 well (012001) was analyzed for chloride, sulfate, and TDS.
4	09/04/96 09/09/96	3	Standard Suite, chloride, TDS, sulfate, dioxins	NA

Notes:
Standard Suite = VOCs, SVOCs, metals, cyanide, pesticides, and PCBs at DQO Level III.

The shallow monitoring wells were installed to 12.5 feet bgs in the upper sand layer of the Wando Formation. All wells were installed in accordance with Section 3.2.3 of this report.

Groundwater samples were also collected from a shallow/deep grid-based monitoring well pair (GDI003/GDI03D) located adjacent to SWMU 12. Both of these wells were sampled during all four sampling events, with analysis for the standard suite of parameters plus chloride, sulfate, and TDS. Samples from both wells were also analyzed for organotins (first-round) and dioxins (GDI003,all rounds; GDI03D, first- and fourth-rounds.

Shallow grid well GDI003 was installed at 12.5 feet bgs in the upper sand layer of the Wando Formation. Deep grid well GDI03D was installed at 62 feet bgs. All wells were installed in accordance with Section 3.2.3 of this report.

Results of the grid-based well sample analyses are presented in Appendix D and discussed below together with groundwater analytical results for SWMU 12.

10.11.4 Nature and Extent of Contamination in Groundwater

Table 10.11.6 summarizes the organic analytical results for groundwater at SWMU 12 and Table 10.11.7 summarizes the inorganic analytical results. Table 10.11.8 summarizes analytes detected in shallow groundwater. Appendix D contains a complete analytical data for all samples collected in Zone I.

Volatile Organic Compounds in Groundwater

Two VOCs – acetone and chlorobenzene – were detected in first-round groundwater samples at concentrations below their respective RBCs. Neither was detected in the fourth-round. (VOCs were not included in groundwater analyses in the second- and third-rounds of sampling.)

Acetone (60 μg/L) was detected in shallow groundwater samples from GDI003 during the first-round at a concentration far below its tap-water RBC and MCL. Acetone (27 μg/L) and xylene (total) (2 μg/L) were detected in deep groundwater samples from GDI03D during the first- and second-rounds, respectively. Both concentrations were far below the respective tap-water RBCs/MCLs. No other VOCs were detected in samples from GDI003/GDI03D.

Semivolatile Organic Compounds in Groundwater

Three SVOCs were detected in groundwater during the first and fourth sampling round. SVOCs were not included in the second and third-round analyses. Di-n-butlyphthalate was the only SVOC detected in the first-round samples. Its concentration of 4.0 μg/L was far below its tap-water

RBC. Benzoic acid was detected in fourth-round sample 012GW00204 at a concentration far below its tap-water RBC. Bis(2-ethylhexyl)phthalate was detected in fourth-round sample 012GW00304 at a concentration of 20 μg/L. This detection exceeded the tap-water RBC of 4.8 μg/L.

Table 10.11.6
SWMU 12
Organic Analytical Results for Groundwater (μg/L)

Parameter	Sample Round	Detection Frequency	Detection Range	Mean	Tap-water RBC/MCL	Number of Samples Exceeding RBC or MCL
Volatile Organic Compounds						
Acetone	First	1/3	8.0	8.0	370/NL	0
	Second	0/0	NA	NA		0
	Third	0/0	NA	NA		0
	Fourth	0/3	ND	ND		0
Chlorobenzene	First	1/3	1.0	1.0	3.5/NL	0
	Second	0/0	NA	NA		0
	Third	0/0	NA	NA		0
	Fourth	0/3	ND	ND		0
Semivolatile Organic Compounds						
Benzoic Acid	First	0/3	ND	ND	15,000/NL	0
	Second	0/0	NA	NA		0
	Third	0/0	NA	NA		0
	Fourth	1/3	1.0	1.0		0
Bis(2-Ethylhexyl)phthalate	First	0/3	ND	ND	4.8/NL	0
	Second	0/0	NA	NA		0
	Third	0/0	NA	NA		0
	Fourth	1/3	20.0	20.0		1
Di-n-butylphthalate	First	1/3	4.0	4.0	370/NL	0
	Second	0/0	NA	NA		0
	Third	0/0	NA	NA		0
	Fourth	0/3	ND	ND		0
Pesticides/PCB						
Endrin aldehyde	First	1/3	0.03	0.03	1.1/2	0
	Second	0/3	ND	ND		0
	Third	0/3	ND	ND		0
	Fourth	0/3	ND	ND		0
Dioxin Compounds and Organotins						
TEQs	First	2/2	3.7E-07 - 4.5E-06	2.43E-06	4.5E-07	1
	Second	0/0	NA	NA		0
	Third	0/0	NA	NA		0
	Fourth	1/3	4.38E-09	4.38E-09		0
1234678-HpCDD	First	2/2	2.03E-06 - 1.49E-05	8.44E-06	4.5E-05/NL	0
	Second	0/0	NA	NA		0
	Third	0/0	NA	NA		0
	Fourth	0/3	ND	ND		0

Table 10.11.6
SWMU 12
Organic Analytical Results for Groundwater (μg/L)

Parameter	Sample Round	Detection Frequency	Detection Range	Mean	Tap-water RBC/MCL	Number of Samples Exceeding RBC or MCL
1234678-HpCDF	First	2/2	4.38E-06 - 1.12E-04	5.8E-05	4.5E-05/NL	1
	Second	0/0	NA	NA		0
	Third	0/0	NA	NA		0
	Fourth	0/3	ND	ND		0
123478-HxCDF	First	1/2	7.69E-06	7.69E-06	4.5E-06/NL	1
	Second	0/0	NA	NA		0
	Third	0/0	NA	NA		0
	Fourth	0/3	ND	ND		0
123678-HxCDD	First	1/2	1.94E-06	1.94E-06	4.5E-06/NL	0
	Second	0/0	NA	NA		0
	Third	0/0	NA	NA		0
	Fourth	0/3	ND	ND		0
123678-HxCDF	First	1/2	7.08E-06	7.08E-06	4.5E-06/NL	1
	Second	0/0	NA	NA		0
	Third	0/0	NA	NA		0
	Fourth	0/3	ND	ND		0
123789-HxCDF	First	2/2	2.95E-06 - 6.77E-06	4.86E-06	4.5E-06/NL	1
	Second	0/0	NA	NA		0
	Third	0/0	NA	NA		0
	Fourth	0/3	ND	ND		0
12378-PeCDF	First	1/2	2.67E-06	2.67E-06	8.9E-06/NL	0
	Second	0/0	NA	NA		0
	Third	0/0	NA	NA		0
	Fourth	0/3	ND	ND		0
234678-HxCDF	First	1/2	2.84E-06	2.84E-06	4.5E-06/NL	0
	Second	0/0	NA	NA		0
	Third	0/0	NA	NA		0
	Fourth	0/3	ND	ND		0
OCDD	First	2/2	4.93E-06 - 1.06E-04	5.5E-05	4.5E-04/NL	0
	Second	0/0	NA	NA		0
	Third	0/0	NA	NA		0
	Fourth	1/3	4.38E-06	4.38E-06		0
OCDF	First	2/2	1.99E-06 - 3.6E-04	1.81E-04	4.5E-04/NL	0
	Second	0/0	NA	NA		0
	Third	0/0	NA	NA		0
	Fourth	0/3	ND	ND		0

Notes:
NL = Not Listed
NA = Not Applicable/Not Available/Not Analyzed
ND = Not Detected/Not Determined
μg/L = microgram per liter
See Table 5.5 for organic compound screening concentrations and their sources.

Table 10.11.7
SWMU 12
Inorganic Analytical Results for Groundwater (μg/L)

Parameter	Sample Round	Detection Frequency	Detection Range	Mean	Tap-water RBC/MCL	Shallow Background	Number of Samples Exceeding Lower of RBC or MCL and Background
Aluminum (Al)	First	0/3	ND	ND	3700/NL	1440	0
	Second	1/3	31.9	31.9			0
	Third	0/3	ND	ND			0
	Fourth	0/3	ND	ND			0
Arsenic (As)	First	1/3	177	177	0.045/50	23	1
	Second	1/3	220	220			1
	Third	1/3	188	188			1
	Fourth	1/3	253	253			1
Barium (Ba)	First	3/3	70.0 - 139	106	260/2000	110	0
	Second	3/3	40.8 - 108	64.5			0
	Third	0/3	ND	ND			0
	Fourth	3/3	53.1 - 119	79.9			0
Beryllium (Be)	First	0/3	ND	ND	7.3/4	1.1	0
	Second	0/3	ND	ND			0
	Third	0/3	ND	ND			0
	Fourth	3/3	0.51 - 0.8	0.62			0
Cadmium (Cd)	First	2/3	0.3 - 3.1	1.7	1.8/5	NA	1
	Second	1/3	1.1	1.1			0
	Third	0/3	ND	ND			0
	Fourth	0/3	ND	ND			0
Calcium (Ca)	First	3/3	175,000 - 655,000	340,000	NL/NL	NL	NA
	Second	3/3	173,000 - 748,000	368,000			NA
	Third	3/3	170,000 - 782,000	378,000			NA
	Fourth	3/3	167,000 - 683,000	346,000			NA
Chromium (Cr)	First	3/3	1.2 - 1.75	1.55	18/100	14.3	0
	Second	0/3	ND	ND			0
	Third	1/3	1.4	1.4			0
	Fourth	0/3	ND	ND			0

Table 10.11.7
SWMU 12
Inorganic Analytical Results for Groundwater (μg/L)

Parameter	Sample Round	Detection Frequency	Detection Range	Mean	Tap-water RBC/MCL	Shallow Background	Number of Samples Exceeding Lower of RBC or MCL and Background
Cobalt (Co)	First	2/3	0.75 - 7.2	3.98	220/NL	2.2	0
	Second	1/3	4.8	4.8			0
	Third	1/3	5.0	5.0			0
	Fourth	1/3	3.7	3.7			0
Iron (Fe)	First	3/3	68.5 - 93,700	31,900	NL/NL	NL	NA
	Second	3/3	119 - 93,500	31,600			NA
	Third	3/3	24.6 - 104,000	34,800			NA
	Fourth	3/3	811 - 48,000	16,700			NA
Lead (Pb)	First	3/3	1.9 - 4.9	3.2	15/15	4.4	0
	Second	0/3	ND	ND			0
	Third	0/3	ND	ND			0
	Fourth	0/3	ND	ND			0
Magnesium (Mg)	First	3/3	318,000 - 651,000	470,000	NL/NL	NL	NA
	Second	3/3	303,000 - 490,000	398,000			NA
	Third	3/3	346,000 - 507,000	440,000			NA
	Fourth	3/3	202,000 - 553,000	383,000			NA
Manganese (Mn)	First	3/3	101 - 4,870	1700	73/261	5430	0
	Second	3/3	66.8 - 4,920	1,701			0
	Third	3/3	56.5 - 2,860	998			0
	Fourth	3/3	62.6 - 2,770	1,018			0
Nickel (Ni)	First	2/3	1.5 - 124	62.8	73/100	13.3	1
	Second	1/3	88.1	88.1			1
	Third	1/3	167	167			1
	Fourth	1/3	48.7	48.7			0
Potassium (K)	First	3/3	151,000 - 285,000	223,000	NL/NL	NL	NA
	Second	3/3	86,800 - 207,000	158,300			NA
	Third	3/3	91,700 - 163,000	137,600			NA
	Fourth	2/3	182,000 - 228,000	205,000			NA

Table 10.11.7
SWMU 12
Inorganic Analytical Results for Groundwater (μg/L)

Parameter	Sample Round	Detection Frequency	Detection Range	Mean	Tap-water RBC/MCL	Shallow Background	Number of Samples Exceeding Lower of RBC or MCL and Background
Selenium (Se)	First	1/3	6.1	6.1	18/50	ND	0
	Second	0/3	ND	ND			0
	Third	0/3	ND	ND			0
	Fourth	0/3	ND	ND			0
Sodium (Na)	First	3/3	1,550,000 - 4,610,000	3,237,000	NL/NL	NL	NA
	Second	3/3	1,900,000 - 4,160,000	3,317,000			NA
	Third	3/3	2,060,000 - 4,830,000	3,860,000			NA
	Fourth	3/3	1,270,000 - 3,800,000	2,710,000			NA
Thallium (Tl)	First	0/3	ND	ND	0.26/2	2.0	0
	Second	0/3	ND	ND			0
	Third	0/3	ND	ND			0
	Fourth	1/3	4.3	4.3			1
Tin (Sn)	First	3/3	236 - 374	299	2,200/NL	NA	0
	Second	0/3	ND	ND			0
	Third	0/3	ND	ND			0
	Fourth	1/3	2.9	2.9			0
Vanadium (V)	First	3/3	1.0 - 10.0	5.07	26/NL	14	0
	Second	3/3	1.8 - 3.5	2.8			0
	Third	0/3	ND	ND			0
	Fourth	0/3	ND	ND			0
Zinc (Zn)	First	3/3	18.0 - 47.2	35.8	1100/NL	24.4	0
	Second	0/3	ND	ND			0
	Third	0/3	ND	ND			0
	Fourth	1/3	5.6	5.6			0

Notes:
NL = Not Listed
NA = Not Applicable/Not Available/Not Analyzed
ND = Not Detected/Not Determined
μg/L = micrograms per liter
See Table 5.6 for inorganic screening concentrations and their sources.

Table 10.11.8
SWMU 12
Analytes Detected in Shallow Groundwater (μg/L)

Parameter	Location	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Tap-water RBC*	MCL/SMCL*	Shallow Background
Volatile Organic Compounds								
Acetone	012GW002	8	NT	NT	ND	370	NA	NA
Chlorobenzene	012GW001	1	NT	NT	ND	3.5	NA	NA
Semivolatile Organic Compounds								
Benzoic acid	012GW002	ND	NT	NT	1	15000	NA	NA
Di-n-butylphthalate	012GW003	4	NT	NT	ND	370	NA	NA
bis(2-Ethylhexyl)phthalate (BEHP)	012GW003	ND	NT	NT	20	4.8	NA	NA
Pesticides and PCBs								
Endrin aldehyde	012GW003	0.03	NT	NT	ND	1.1	2	NA
Dioxin Compounds								
2,3,7,8-TCDD equivalents (TEQs)	012GW001	4.50	NT	NT	ND	0.45	30	NA
	012GW002	ND	NT	NT	0.004			
123678-HxCDD	012GW001	1.938	NT	NT	ND	4.5	NA	NA
1234678-HpCDD	012GW001	14.857	NT	NT	ND	45	NA	NA
	012GW003	2.031	NT	NT	ND			
OCDD	012GW001	105.868	NT	NT	ND	450	NA	NA
	012GW002	ND	NT	NT	4.38			
	012GW003	4.928	NT	NT	ND			
12378-PeCDF	012GW001	2.671	NT	NT	ND	8.9	NA	NA
123478-HxCDF	012GW001	7.691	NT	NT	ND	4.5	NA	NA

Table 10.11.8
SWMU 12
Analytes Detected in Shallow Groundwater (μg/L)

Parameter	Location	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Tap-water RBC*	MCL/SMCL*	Shallow Background
123678-HxCDF	012GW001	7.076	NT	NT	ND	4.5	NA	NA
123789-HxCDF	012GW001	6.766	NT	NT	ND	4.5	NA	NA
	O12GW003	2.95	NT	NT	ND			
234678-HxCDF	012GW001	2.838	NT	NT	ND	4.5	NA	NA
1234678-HpCDF	012GW001	111.889	NT	NT	ND	45	NA	NA
	012GW003	4.379	NT	NT	ND			
OCDF	012GW001	359.642	NT	NT	ND	450	NA	NA
	012GW003	1.985	NT	NT	ND			
Inorganics (mg/L)								
Aluminum (Al)	012GW001	ND	31.9	ND	ND	3700	NL	1440
Arsenic (As)	012GW002	177	220	188	253	0.045	50	23
Barium (Ba)	012GW001	70	40.8	ND	53.1	260	2000	110
	012GW002	139	108	ND	119			
	012GW003	108.85	44.7	ND	67.6			
Beryllium (Be)	012GW001	ND	ND	ND	0.51	7.3	4	1.1
	012GW002	ND	ND	ND	0.8			
	012GW003	ND	ND	ND	0.55			
Cadmium (Cd)	012GW002	3.1	1.1	ND	ND	1.8	5	NA
	012GW003	0.3	ND	ND	ND			

Table 10.11.8
SWMU 12
Analytes Detected in Shallow Groundwater (μg/L)

Parameter	Location	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Tap-water RBC*	MCL/SMCL*	Shallow Background
Chromium (Cr) (total)	012GW001	1.7	ND	ND	ND	18	100	14.3
	012GW002	1.2	ND	1.4	ND			
	012GW003	1.75	ND	ND	ND			
Cobalt (Co)	012GW002	7.2	4.8	5	3.7	220	NL	2.2
	012GW003	0.75	ND	ND	ND			
Lead (Pb)	012GW001	1.9	ND	ND	ND	15	15	4.4
	012GW002	4.9	ND	ND	ND			
	012GW003	2.9	ND	ND	ND			
Manganese (Mn)	012GW001	129	116	76.5	222	73	NL	5430
	012GW002	4870	4920	2860	2770			
	012GW003	100.75	66.8	56.5	62.6			
Nickel (Ni)	012GW002	124	88.1	167	48.7	73	100	13.3
	012GW003	1.5	ND	ND	ND			
Selenium (Se)	012GW002	6.1	ND	ND	ND	18	50	ND
Thallium (Tl)	012GW003	ND	ND	ND	4.3	0.26	2	6.6
Tin (Sn)	012GW001	288	ND	ND	ND	2200	NL	NA
	012GW002	374	ND	ND	ND			
	012GW003	236	ND	ND	2.9			

Table 10.11.8
SWMU 12
Analytes Detected in Shallow Groundwater (μg/L)

Parameter	Location	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Tap-water RBC*	MCL/SMCL*	Shallow Background
Vanadium (V)	012GW001	4.2	3.5	ND	ND	26	NL	14
	012GW002	10	3.1	ND	ND			
	012GW003	ND	1.8	ND	ND			
	012GW003	1	ND	ND	ND			
Zinc (Zn)	012GW001	43.4	ND	ND	ND	1100	NL	24.4
	012GW002	47.2	ND	ND	5.6			
	012GW003	18	ND	ND	ND			

Notes:

* = Tap-water RBCs (THQ=0.1) from *Risk-Based Concentration Table* (USEPA, October 22, 1997), and MCLs/SMCLs from *Drinking Water Regulations and Health Advisories* (USEPA, 1996e)

Bold concentrations exceed both the RBC and the zone background

All background values for Zone I are based on twice the means of the grid sample concentrations. Background values for the groundwater are based on two sampling rounds in two wells at each depth.

NA = Not applicable/not available
ND = Not detected
NL = Not listed
NT = Not taken
RBC = Risk-based concentration
pg/L = Picograms per liter
mg/kg = Micrograms per kilogram
μg/L = Micrograms per liter

Acetophenone (1 μg/L) was detected in first-rounds shallow groundwater samples from GDI003 at a concentration above its tap-water RBC (0.0042 μg/L). No other SVOCs were detected in samples from GDI003.

Benzoic acid (1 μg/L) and diethylphthalate (2 μg/L) were detected in deep groundwater samples from GDI03D. Both concentrations were far below their respective tap-water RBCs. No other SVOCs were detected at GDI03D.

Pesticides and PCBs in Groundwater

One pesticide, endrin aldehyde, was detected in the first-round sample from well 012003 at a concentration of 0.03 μg/L, far below the RBC/MCL. No other pesticides or PCBs were detected in site groundwater.

No pesticides or PCBs were detected in shallow or deep groundwater samples from grid-based wells GDI003/GDI03D.

Other Organic Compounds in Groundwater

Dioxins and furans were detected in one duplicate sample from well 012003 and one primary sample collected at well 012001. In accordance with recent dioxin guidance (USEPA *Interim Supplemental Guidance to RAGS: Region IV Bulletins Human Health Risk Assessment*, Bulletin No. 2 [USEPA 1995a]), and Section 7 of this report, TEQs of 3.7E-7 μg/L and 4.5E-6 μg/L were calculated for samples 012GW00301 and 012GW00101, respectively. Dioxins were also included in the analyses during the fourth-round. The TEQ for the fourth-round sample from well 012002 was 4.38E-9 μg/L. None of the TEQs for dioxin analyses exceeded the 4.75E-7 μg/L RBC.

Dioxins were also detected in the groundwater samples collected from GDI003 and GDI03D. Dioxins were detected in all four rounds of sampling for the shallow well (GDI003). Calculated

TEQs ranged from 8.9E-9 μg/L to 3.41E-6 μg/L. TEQs calculated for GDI00303 (1.76E-6 μg/L) and GDI00304 (3.41E-6 μg/L) are above the RBC.

Dioxins were detected in the first-round deep well sample. The TEQ calculated for this sample was 7.27E-7 μg/L, which is below the MCL.

Inorganics in Groundwater

Twenty metals were detected in SWMU 12 groundwater over the four sampling rounds; however only four – arsenic, cadmium, nickel, and thallium – exceeded their respective screening criteria. Arsenic exceeded its tap-water RBC, MCL, and shallow background concentration in all four sampling events, with concentrations ranging from 177 to 253 μg/L. All of these exceedances were in samples from well 012002; the maximum concentration was detected in the fourth-round sample. Arsenic was not detected in any other SWMU 12 well. Cadmium was detected in the first- and second-round samples, but exceeded screening concentrations only in the first-round sample at well 012003. Nickel was detected in all four sampling rounds at well 012002, with concentrations ranging from 48.7 to 167 μg/L. The screening criteria for nickel were exceeded in the first three sampling rounds. Thallium exceeded its screening criteria in the fourth-round sample from well 012003 (4.3 μg/L). Thallium was not detected in the first three rounds.

Nineteen metals were detected in shallow groundwater samples from GDI003, e.g., with only two exceedances. Antimony (3.1 μg/L) exceeded its tap-water RBC in the third-round sample. Thallium (2.8 μg/L) exceeded its tap-water RBC and shallow groundwater background concentration also in the third-round sample. There were no other exceedances.

Seventeen metals were detected in deep groundwater samples from GDI03D. Only one, antimony exceeded its tap-water RBC (6.1 μg/L in the third-round sample). There was no exceedance of MCL or background.

10.11.5 Fate and Transport Assessment

SWMU 12 is the former firefighter training area in the southwestern portion of the southern peninsula. At this SWMU, flammable liquids were pumped into a shallow 30-foot to 50-foot diameter pit, ignited, and then extinguished with water. Training occurred between 1966 and 1971; the frequency of training and types of flammable liquids used are not documented. A gravel road and a clearing at the SWMU, currently used infrequently as a construction laydown yard, are reportedly near the former training area's location.

Materials of concern include petroleum hydrocarbons, coal ash, SVOCs, and metals. Environmental media sampled in this investigation include surface soil, subsurface soil, and shallow groundwater. Potential constituent migration pathways investigated for SWMU 12 include soil-to-groundwater, groundwater to human receptors and to surface water, and emission of volatiles from surface soil-to-air.

10.11.5.1 Soil-to-groundwater Cross-media Transport

Tables 10.11.9 and 10.11.10 compare maximum detected organic and inorganic constituent concentrations, respectively, in surface and subsurface soil samples to risk-based soil screening levels considered protective of groundwater. Maximum concentrations in soil are compared to leachability-based generic SSLs. The generic SSLs are used to provide a conservative screen; leachate entering the aquifer is assumed to be diluted by a ratio of 10:1, with no attenuation of constituents in soil (DAF=10). Soil background values for inorganics in Zone I were determined, but at the direction of SCDHEC, were not considered during initial comparisons of maximum soil concentrations with SSLs.

Table 10.11.9
Organic Chemicals Detected in Surface Soil, Subsurface Soil, and Shallow Groundwater
Comparison to Cross-Media SSLs, Tap-Water RBCs, and Saltwater Surface Water Chronic Screening Levels
SWMU 12
Charleston Naval Complex
Charleston, South Carolina

Parameter	Maximum Concentration Surface Soil	Subsurface Soil	Sediment	Shallow GW	Screening Concentration Soil to GW SSL	Soil to Air SSL	Tap-Water RBC	Saltwater Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Volatilization Potential	Ground-water Migration Concern	Surface Water Migration Concern
Volatile Organic Compounds														
Acetone	67	NA	NA	8	8000	1.0E+08	3700	NA	µG/KG	µG/L	NO	NO	NO	NO
2-Butanone (MEK)	13	NA	NA	ND	3900 a	NA	1900	NA	µG/KG	µG/L	NO	NO	NO	NO
Chlorobenzene	ND	NA	NA	1	700	130000	35	105	µG/KG	µG/L	NO	NO	NO	NO
Toluene	27	NA	NA	ND	6000	650000	750	37	µG/KG	µG/L	NO	NO	NO	NO
Semivolatile Organic Compounds														
Benzoic acid	ND	NA	NA	1	200000	NA	150000	NA	µG/KG	µG/L	NO	NO	NO	NO
Benzo(a)pyrene Equivalents	147	NA	NA	ND	1600 a	NA	0.0092	NA	µG/KG	µG/L	NO	NO	NO	NO
Benzo(a)anthracene c	67	NA	NA	ND	800	NA	0.092	NA	µG/KG	µG/L	NO	NO	NO	NO
Benzo(a)pyrene c	100	NA	NA	ND	4000	NA	0.0092	NA	µG/KG	µG/L	NO	NO	NO	NO
Benzo(b)fluoranthene c	360	NA	NA	ND	2500	NA	0.092	NA	µG/KG	µG/L	NO	NO	NO	NO
Benzo(k)fluoranthene c	390	NA	NA	ND	25000	NA	0.92	NA	µG/KG	µG/L	NO	NO	NO	NO
Chrysene c	130	NA	NA	ND	80000	NA	9.2	NA	µG/KG	µG/L	NO	NO	NO	NO
Di-n-butylphthalate	ND	NA	NA	4	2300000	2300000	3700	3.4	µG/KG	µG/L	NO	NO	NO	YES
bis(2-Ethylhexyl)phthalate (BEHP) c	2400	NA	NA	20	1800000	31000000	4.8	NA	µG/KG	µG/L	NO	NO	YES	NO
Fluoranthene	81	NA	NA	ND	2100000	NA	1500	1.6	µG/KG	µG/L	NO	NO	NO	NO
Pyrene	180	NA	NA	ND	2100000	NA	1100	NA	µG/KG	µG/L	NO	NO	NO	NO
Pesticides/PCBs														
beta-BHC (beta-HCH) c	8	NA	NA	ND	1.3	1E+09	0.037	NA	µG/KG	µG/L	YES	NO	NO	NO
4,4'-DDE c	0.64	NA	NA	ND	27000	NA	0.2	0.14	µG/KG	µG/L	NO	NO	NO	NO
4,4'-DDT c	1.3	NA	NA	ND	16000	1E+09	0.2	0.001	µG/KG	µG/L	NO	NO	NO	NO
Endosulfan II	6.55	NA	NA	ND	9000 b	NA	220	0.0087	µG/KG	µG/L	NO	NO	NO	NO
Endrin aldehyde	3.6	NA	NA	0.03	340 a	NA	11	NA	µG/KG	µG/L	NO	NO	NO	NO
Heptachlor epoxide c	4.3	NA	NA	ND	330	5000	0.0012	0.0036	µG/KG	µG/L	NO	NO	NO	NO
Methoxychlor	1.3	NA	NA	ND	80000	NA	180	0.03	µG/KG	µG/L	NO	NO	NO	NO
Organotin														
Tetrabutyltin	316	NA	NA	ND	NA	NA	11	NA	µG/KG	µG/L	NO	NO	NO	NO
Dioxin Compounds														
2,3,7,8-TCDD equivalents (TEQs) c	0.337	NA	NA	4.5	1600 a	NA	0.45	10	NG/KG	PG/L	NO	NO	YES	NO
123678-HxCDD c	ND	NA	NA	1.94	4100 a	NA	4.5	NA	NG/KG	PG/L	NO	NO	NO	NO

Table 10.11.9
Organic Chemicals Detected in Surface Soil, Subsurface Soil, and Shallow Groundwater
Comparison to Cross-Media SSLs, Tap-Water RBCs, and Saltwater Surface Water Chronic Screening Levels
SWMU 12
Charleston Naval Complex
Charleston, South Carolina

Parameter	Maximum Concentration: Surface Soil	Maximum Concentration: Subsurface Soil	Maximum Concentration: Sediment	Maximum Concentration: Shallow GW	Screening Concentration: Soil to GW SSL	Screening Concentration: Soil to Air SSL	Screening Concentration: Tap-Water RBC	Screening Concentration: Saltwater Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Volatilization Potential	Ground-water Migration Concern	Surface Water Migration Concern
1234678-HpCDD c	12.9	NA	NA	14.9	108000 a	NA	45	NA	NG/KG	PG/L	NO	NO	NO	NO
OCDD c	182	NA	NA	106	1080000 a	NA	450	NA	NG/KG	PG/L	NO	NO	NO	NO
12378-PeCDF c	ND	NA	NA	2.67	800 a	NA	8.9	NA	NG/KG	PG/L	NO	NO	NO	NO
123478-HxCDF c	ND	NA	NA	7.69	216000 a	NA	4.5	NA	NG/KG	PG/L	NO	NO	YES	NO
123678-HxCDF c	ND	NA	NA	7.08	216000 a	NA	4.5	NA	NG/KG	PG/L	NO	NO	YES	NO
123789-HxCDF c	ND	NA	NA	6.77	216000 a	NA	4.5	NA	NG/KG	PG/L	NO	NO	YES	NO
234678-HxCDF c	ND	NA	NA	2.84	216000 a	NA	4.5	NA	NG/KG	PG/L	NO	NO	NO	NO
1234678-HpCDF c	2.11	NA	NA	112	54000 a	NA	45	NA	NG/KG	PG/L	NO	NO	YES	NO
OCDF c	4.73	NA	NA	360	540000 a	NA	450	NA	NG/KG	PG/L	NO	NO	NO	NO

Notes:
Sources of screening concentrations appear in Table 5.5
Explanations of fate and transport screening procedures appear in Section 6.2.
Frequency and range of detections, average detected concentrations, and number of screening concentration exceedances appear in Tables 10.11.2 and 10.11.6.

a - Calculated soil to groundwater SSL value (See Table 6.2)
b - Based on surrogate compound; see Table 5.5
c - Carcinogenic
GW - Groundwater

NA - Not applicable/not available
ND - Not detected
RBC - Risk-based concentration
SSL - Soil screening level

NG/KG - Nanograms per kilogram
µG/KG - Micrograms per kilogram
PG/L - Picograms per liter
µG/L - Micrograms per liter

Table 10.11.10
Inorganic Chemicals Detected in Surface Soil, Subsurface Soil, and Shallow Groundwater
Comparison to Cross-Media SSLs, Tap-Water RBCs, Saltwater Surface Water Chronic Screening Levels, and Background Values
SWMU 12
Charleston Naval Complex
Charleston, South Carolina

Parameter	Maximum Concentration: Surface Soil	Subsurface Soil	Sediment	Shallow GW	Screening Concentration: Soil to GW SSL	Soil Background	Soil to Air SSL	Tap Water RBC	Shallow GW Background	Saltwater Surf. Wtr Chronic	Soil Units	Water Units	Leaching Potential	Fugitive Particulate Inhalation Concern	Ground-water Migration Concern	Surface Water Migration Concern
Inorganic Chemicals																
Aluminum (Al)	17900	NA	NA	31.9	560000 a	27400	NA	37000	1440	NA	MG/KG	µG/L	NO	NO	NO	NO
Antimony (Sb)	0.49	NA	NA	ND	2.7	ND	NA	15	NA	NA	MG/KG	µG/L	NO	NO	NO	NO
Arsenic (As) c	14.2	NA	NA	253	15	21.6	750	0.045	23	36	MG/KG	µG/L	NO	NO	YES	YES
Barium (Ba)	27.3	NA	NA	139	820	54.2	690000	2600	110	NA	MG/KG	µG/L	NO	NO	NO	NO
Beryllium (Be)	0.63	NA	NA	0.8	32	0.95	1300	73	1.1	NA	MG/KG	µG/L	NO	NO	NO	NO
Cadmium (Cd)	0.46	NA	NA	3.1	4	0.61	1800	18	NA	9.3	MG/KG	µG/L	NO	NO	NO	NO
Chromium (Cr) (total)	39	NA	NA	1.75	19	51.3	270	180	14.3	50	MG/KG	µG/L	YES	NO	NO	NO
Chromium (Cr6) (hexavalent)	0.415	NA	NA	ND	19	ND	270	180	ND	50	MG/KG	µG/L	NO	NO	NO	NO
Cobalt (Co)	3.7	NA	NA	7.2	990 a	5.8	NA	2200	2.2	NA	MG/KG	µG/L	NO	NO	NO	NO
Copper (Cu)	27.7	NA	NA	ND	5600 a	240	NA	1500	4.4	2.9	MG/KG	µG/L	NO	NO	NO	NO
Lead (Pb)	19.3	NA	NA	4.9	400	203	400	15	4.4	8.5	MG/KG	µG/L	NO	NO	NO	NO
Manganese (Mn)	286	NA	NA	4920	480 a	419	NA	730	5430	NA	MG/KG	µG/L	NO	NO	NO	NO
Mercury (Hg)	0.24	NA	NA	ND	1	0.47	10	11	NA	0.025	MG/KG	µG/L	NO	NO	NO	NO
Nickel (Ni)	17	NA	NA	167	65	23.9	13000	730	13.3	8.3	MG/KG	µG/L	NO	NO	NO	YES
Selenium (Se)	1.8	NA	NA	6.1	2.6	1.77	NA	180	ND	71	MG/KG	µG/L	NO	NO	NO	NO
Thallium (Tl)	ND	NA	NA	4.3	0.36	ND	NA	2.6	2	21.3	MG/KG	µG/L	NO	NO	YES	NO
Tin (Sn)	1.4	NA	NA	374	5500 a	7.5	NA	22000	NA	NA	MG/KG	µG/L	NO	NO	NO	NO
Vanadium (V)	34.9	NA	NA	10	3000	113	NA	260	14	NA	MG/KG	µG/L	NO	NO	NO	NO
Zinc (Zn)	54.6	NA	NA	47.2	6200	206	NA	11000	24.4	86	MG/KG	µG/L	NO	NO	NO	NO

Notes:
Sources of screening concentrations appear in Table 5.6
Explanations of fate and transport screening procedures appear in Section 6.2.
Frequency and range of detections, average detected concentrations, and number of screening concentration exceedances appear in Tables 10.11.3 and 10.11.7.

Background values for soil are shown for comparison purposes only.
Maximum groundwater concentrations are screened against the greater of tap-water RBCs or corresponding background values to determine groundwater migration concern.

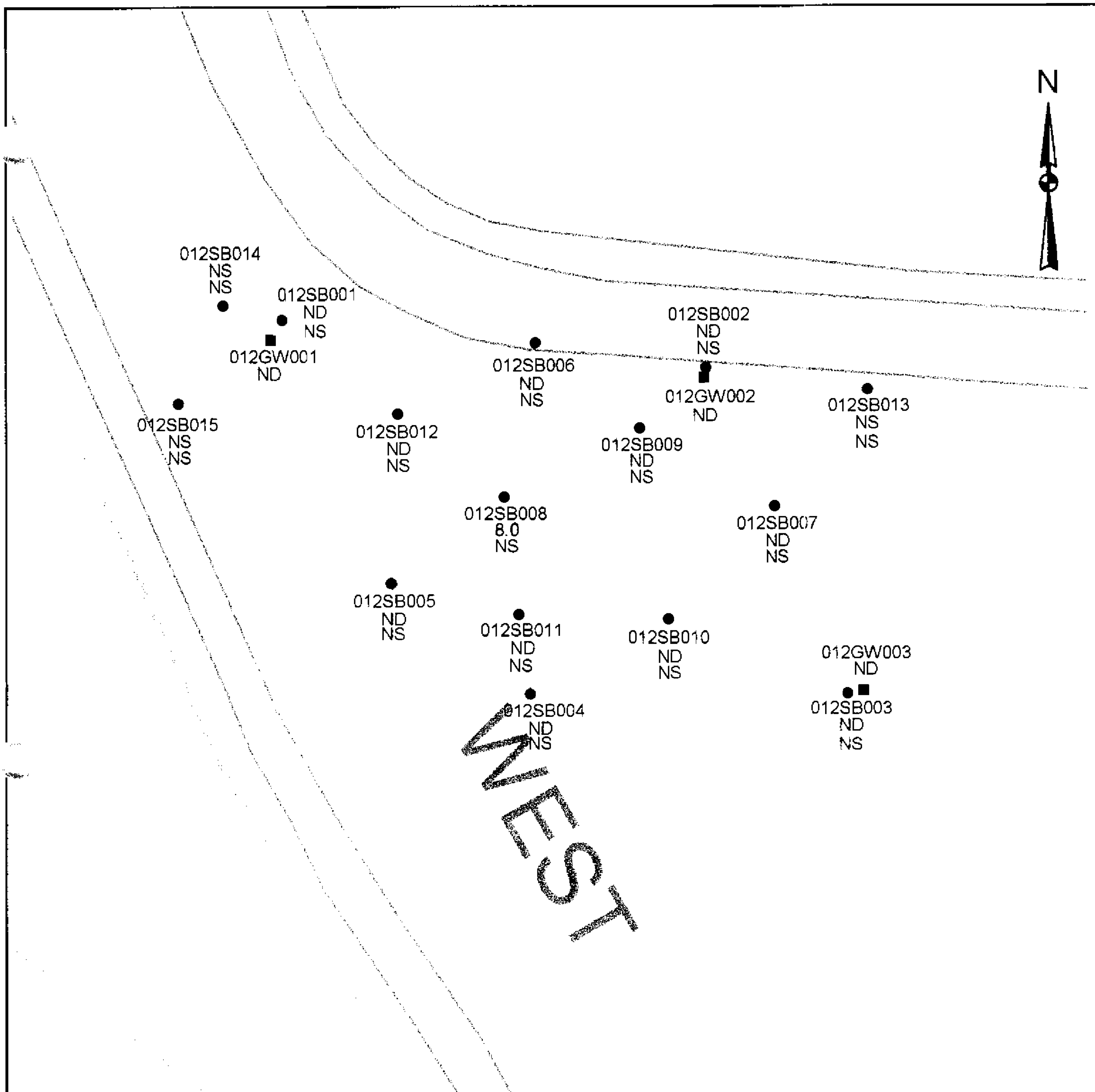
a - Calculated soil to groundwater SSL value (See Table 6.2)
c - Carcinogenic
GW - Groundwater
NA - Not available/Not applicable
ND - Not detected
RBC - Risk-based concentration
SSL - Soil screening level
MG/KG - Milligrams per kilogram
µG/L - Micrograms per liter

Only one organic constituent – beta-BHC – was detected in surface soil at a concentration exceeding the groundwater protection SSL. Due to the high water table at this SWMU, subsurface soils were not sampled. Beta-BHC was detected in only one of 12 soil samples (at a concentration only slightly above the SSL) and, importantly, was nondetect in site groundwater. Figure 10.11.2 presents beta-BHC concentrations detected at SWMU 12. The data indicate that there is very little residual mass of this constituent in soil, and that it poses little risk to groundwater.

Only one inorganic – chromium – was detected in surface soil at concentrations exceeding its SSL. It was widely detected in soil and was consistently above the SSL. Figure 10.11.3 presents chromium concentrations detected at SWMU 12. Chromium in soil is a zone-wide occurrence, however, and all concentrations at SWMU 12 were below the zone-specific background. Chromium was also present in site groundwater, indicating a contribution from either site soil or aquifer matrix, but the highest concentration was far below any screening level. In summary, the soil-to-groundwater pathway for chromium is valid, but it is not expected to be significant.

10.11.5.2 Groundwater Migration and Surface Water Cross-Media Transport

Tables 10.11.9 and 10.11.10 compare maximum detected organic and inorganic constituent concentrations, respectively, in shallow groundwater samples to risk-based concentrations for drinking water, and to chronic ambient saltwater quality criteria values for the protection of aquatic life (saltwater surface water chronic screening values). For inorganics, maximum concentrations in groundwater are screened against the saltwater surface water chronic values as well as the greater of (a) risk-based drinking water concentrations and (b) corresponding background reference concentrations for groundwater. To provide a conservative screening, no attenuation or dilution of constituents in groundwater is assumed before comparison to the relevant standards. The risk-based pathway for shallow groundwater is currently invalid simply because there is no human consumption of the groundwater, i.e. there is no end-use receptor. This comparison is made for screening only, and to develop strategies for long-term management of the groundwater should deleterious levels be identified.



LEGEND

■	MONITORING WELL LOCATION
●	ZONE I SOIL BORING LOCATION
12.30	ZONE I SURFACE SOIL CONC. (UG/KG)
12.30	ZONE I SUBSURFACE SOIL CONC. (UG/KG)
12.30	MAXIMUM QUARTERLY GW CONC. (UG/L)
NS	NO SAMPLE TAKEN
ND	NON DETECT

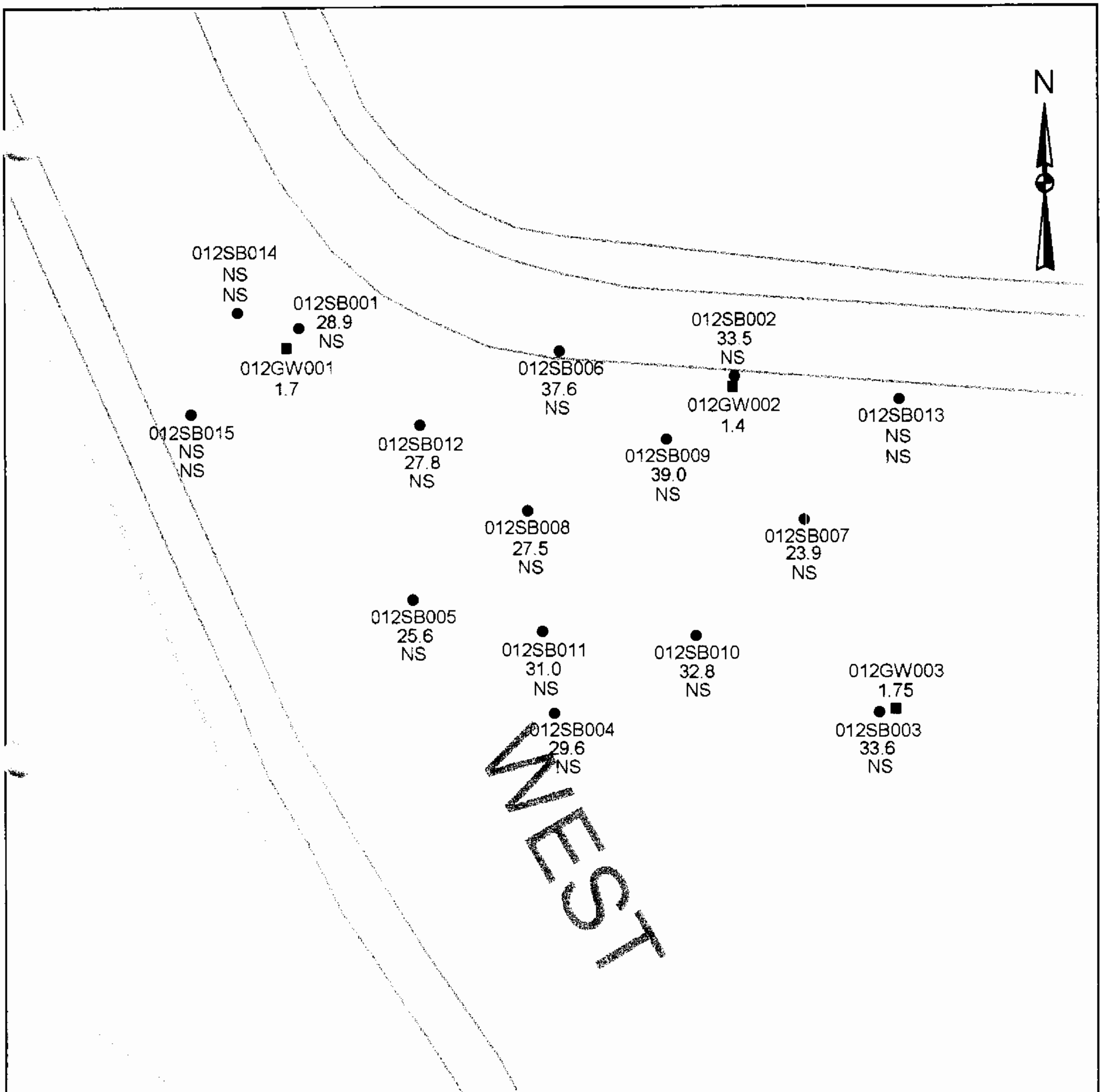
SCALE

20 0 20 40 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.11.2
ZONE I
SWMU 12
BETA-BHC
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=NA RBC=350 UG/KG SSL=1.3 UG/KG



LEGEND

■	MONITORING WELL LOCATION
●	ZONE I SOIL BORING LOCATION
12.30	ZONE I SURFACE SOIL CONC. (MG/KG)
12.30	ZONE I SUBSURFACE SOIL CONC. (MG/KG)
12.30	MAXIMUM QUARTERLY GW CONC. (UG/L)
NS	NO SAMPLE TAKEN
ND	NON DETECT

SCALE

20 0 20 40 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.11.3
ZONE I
SWMU 12
CHROMIUM
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=100 UG/L RBC=39 MG/KG SSL=19 MG/KG

Organic Compounds

One SVOC – bis(2-ethylhexyl)phthalate (BEHP) - was present in groundwater at a concentration above its RBC. Figure 10.11.4 presents BEHP concentrations detected at SWMU 12. It was present only in one of three groundwater samples, and only in the fourth-quarter of sampling. BEHP was present in two of 14 soil samples, but its maximum concentration was far below the SSL. Given its sporadic occurrence in groundwater, its presence may be from a source other than soil. Its persistence in site groundwater will be validated with additional quarterly groundwater sampling, but the limited detection and relatively low concentration of BEHP suggest that is not significant to the risk-based pathway.

Dioxins

Five dioxin species – TEQs, 123478-HxCDF, 123678HxCDF, 123789HxCDF, and 1234678HxCDF – were present in groundwater at concentrations exceeding their respective RBCs. Figures 10.11.5 through 10.11.9 present concentrations for each chemical detected. All were either well below their SSLs or were nondetect in site soil. Additionally, the TEQ calculated for the last quarter of sampling was below the RBC. Dioxins are typically associated with herbicides; thus their presence is inconsistent with past site activities. Their low concentration in surface soil suggests a source linked with herbicide application upgradient of SWMU 12. TEQ below the RBC in the most recent samples indicates that it is not significant to the pathway.

Inorganic Compounds

Two inorganic constituents – arsenic and thallium – were present in groundwater at levels that exceeded the applicable drinking water risk-based migration pathway criteria. Arsenic was detected consistently in well 012002 in four quarters of sampling; concentrations varied somewhat but have been within the same order of magnitude, all significantly above the RBC. Arsenic is also present at low levels in site soil. Figure 10.11.10 presents arsenic concentrations detected at SWMU 12. Arsenic is not expected to be associated with fire-training activities, and its presence is probably associated with non-native fill material or natural soil lithology (its zone-specific soil background value is greater than the SSL).

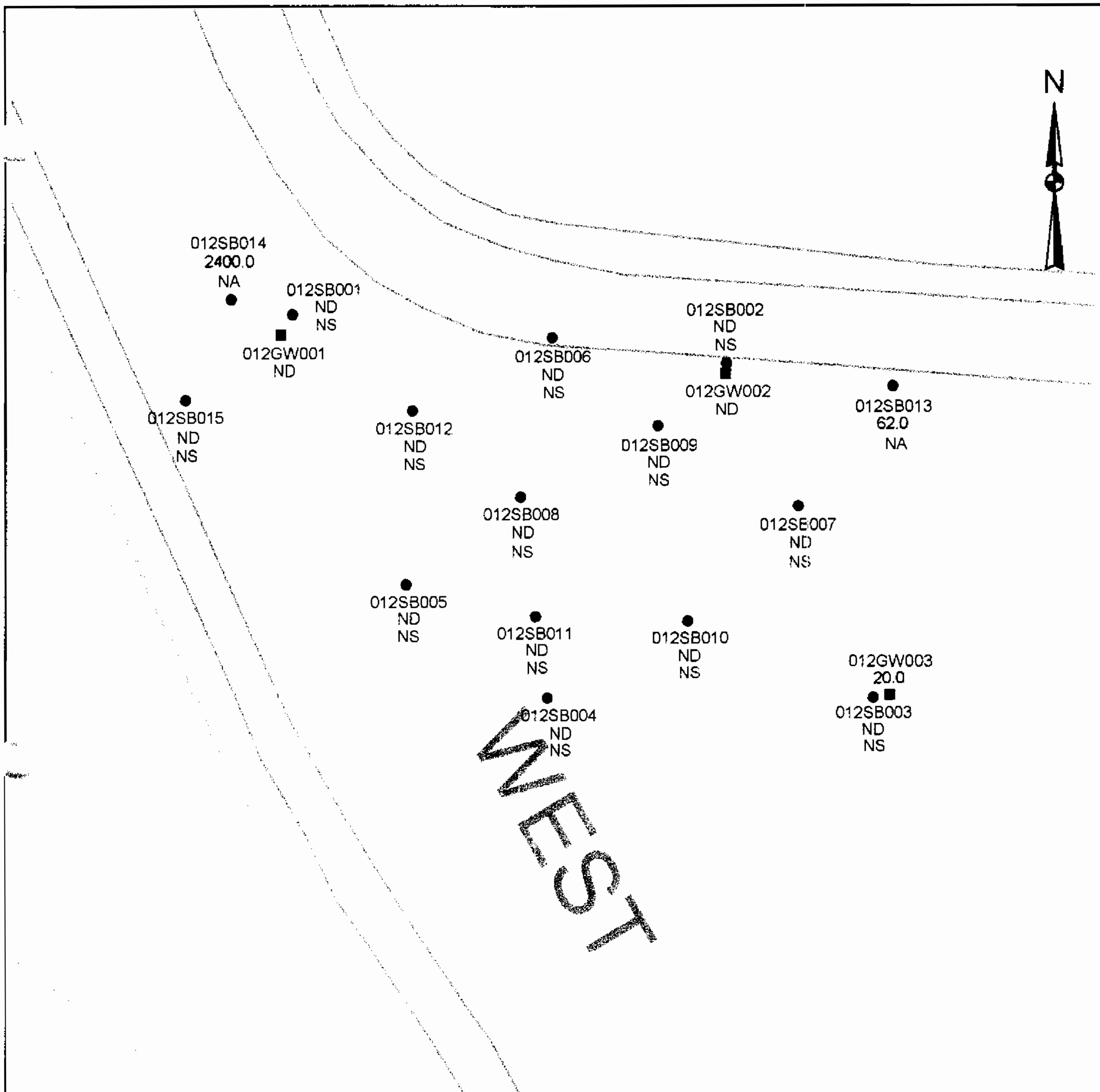
Thallium was detected in only one well, and only in the last quarter of sampling. Figure 10.11.11 presents thallium concentrations detected at SWMU 12. Thallium has been detected consistently in Zone I groundwater above the RBC, indicating a non-point source (such as natural occurrence). At SWMU 12, thallium was nondetect in surface soil, indicating that its presence in site groundwater is not associated with fire-training activities, but from another source (potentially an aquifer matrix composed of either natural lithology or non-native fill).

In summary, the pathway for inorganics is chemically valid, but their significance to the site is questionable due to infrequent detections and questionable sources. Their persistence in groundwater and the spatial trends of occurrence should be validated to refine this analysis and determine significance.

Other Constituents

Three constituents – di-N -butylphthalate, arsenic, and nickel – were present in groundwater above their respective surface water screening criteria. Di-N-butylphthalate was present only in one well and only in the first quarter. It has been below detection limits since, thus invalidating the pathway for this constituent. Figure 10.11.12 presents di-n-butylphthalate concentrations detected. Both arsenic and nickel were significantly above the screening criteria and zone-specific background, confirming their validity to the pathway. Each was detected in each quarter of sampling in one well at a relatively consistent concentration.

Neither arsenic (Figure 10.11.10) or nickel (Figure 10.11.13) is expected to be associated with fire-training operations.



LEGEND

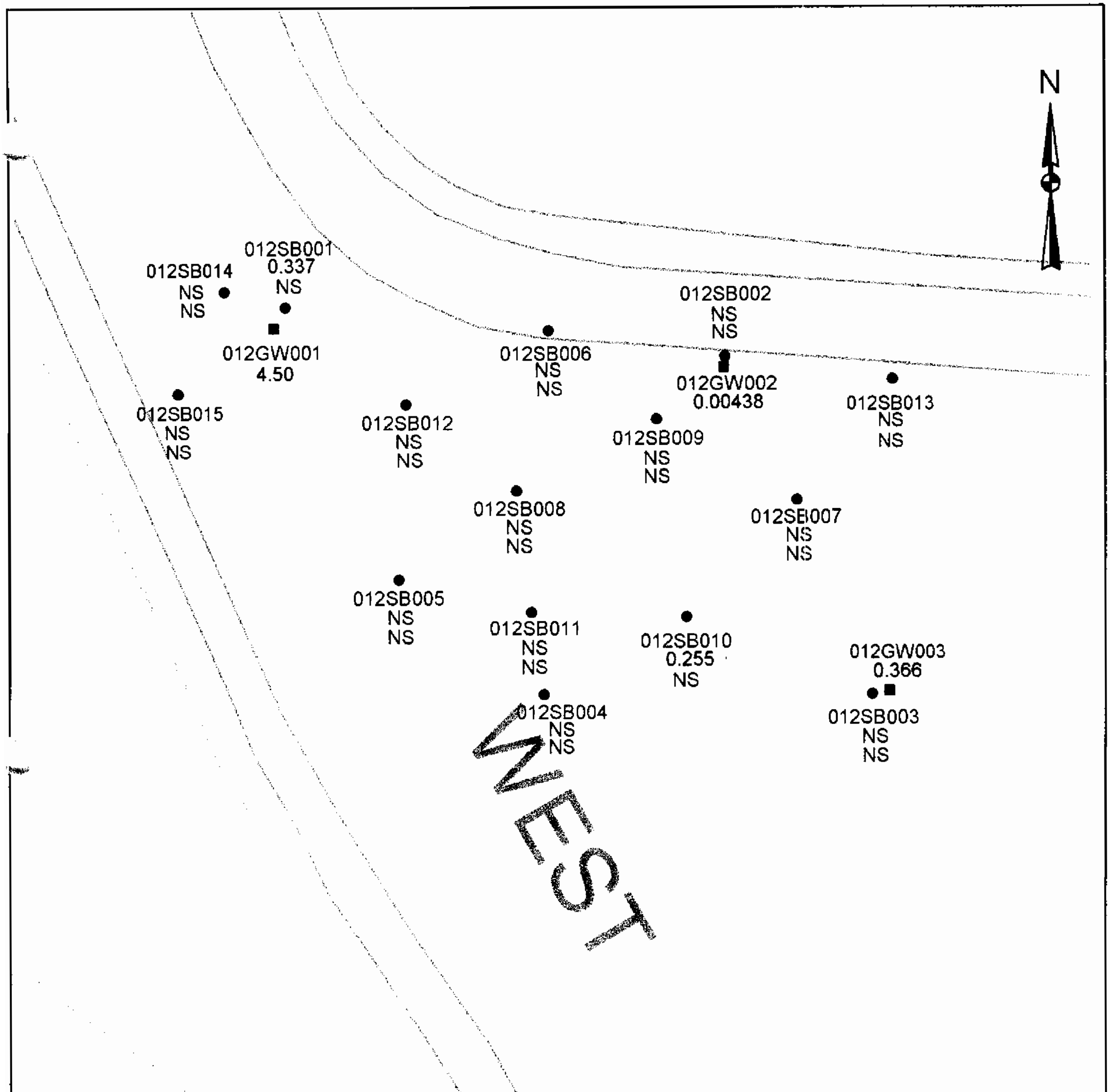
■ MONITORING WELL LOCATION
● ZONE I SOIL BORING LOCATION
12.30 ZONE I SURFACE SOIL CONC. (UG/KG)
12.30 ZONE I SUBSURFACE SOIL CONC. (UG/KG)
12.30 MAXIMUM QUARTERLY GW CONC. (UG/L)
NS NO SAMPLE TAKEN
ND NON DETECT

SCALE
20 0 20 40 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.11.4
ZONE I
SWMU 12
BIS(2-ETHYLHEXYL)PHTHALATE
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=NA RBC=46000 UG/KG SSL=1800000 UG/KG



LEGEND

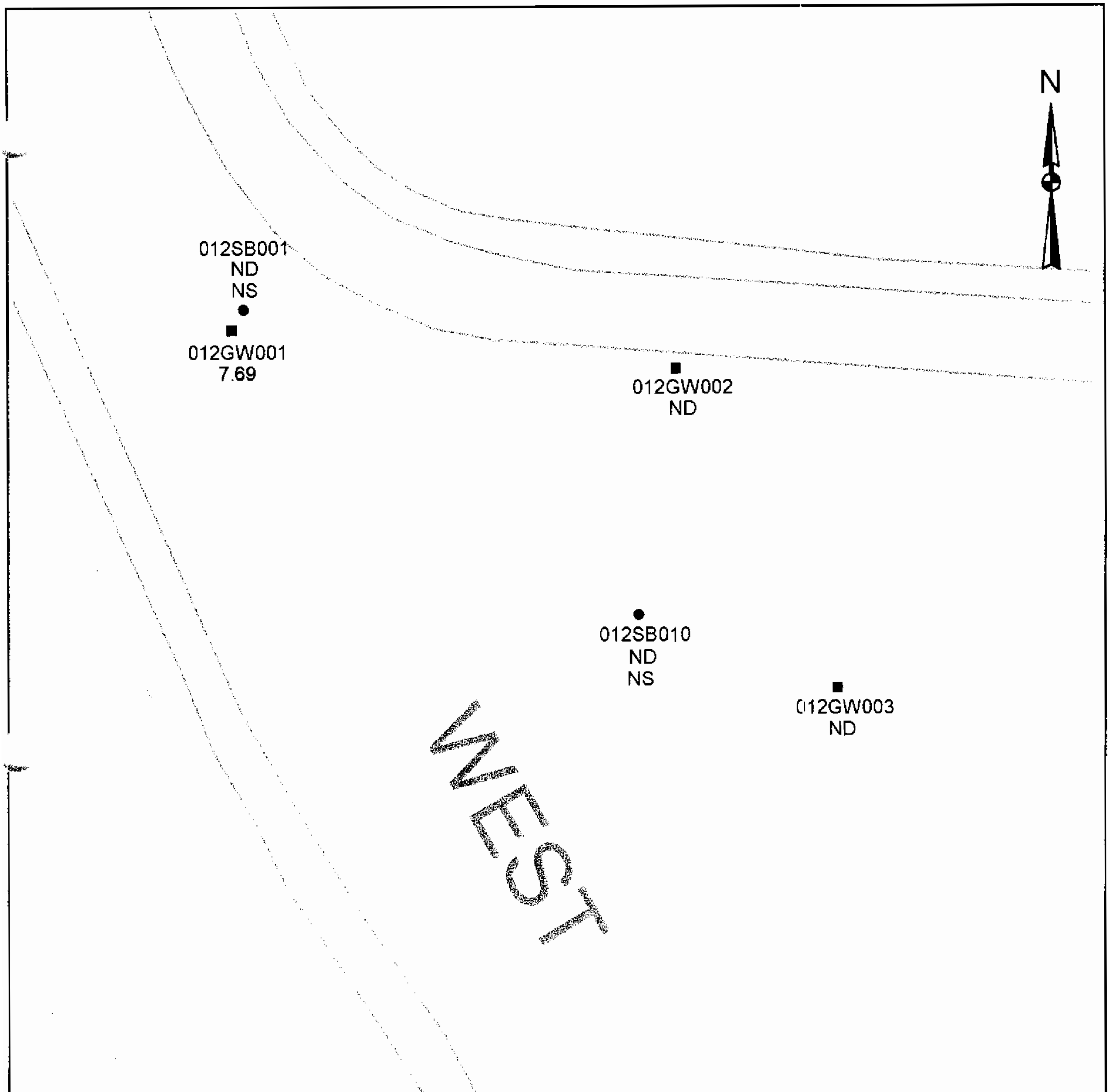
■ MONITORING WELL LOCATION
● ZONE I SOIL BORING LOCATION
12.30 ZONE I SURFACE SOIL CONC. (NG/KG)
12.30 ZONE I SUBSURFACE SOIL CONC. (NG/KG)
12.30 MAXIMUM QUARTERLY GW CONC. (PG/L)
NS NO SAMPLE TAKEN
ND NON DETECT

SCALE
20 0 20 40 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.11.5
ZONE I
SWMU 12
TEQs
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=30 PG/L RBC=4.3 NG/KG SSL=1600 NG/KG



LEGEND

■	MONITORING WELL LOCATION
●	ZONE I SOIL BORING LOCATION
12.30	ZONE I SURFACE SOIL CONC. (NG/KG)
12.30	ZONE I SUBSURFACE SOIL CONC. (NG/KG)
12.30	MAXIMUM QUARTERLY GW CONC. (PG/L)
NS	NO SAMPLE TAKEN
ND	NON DETECT

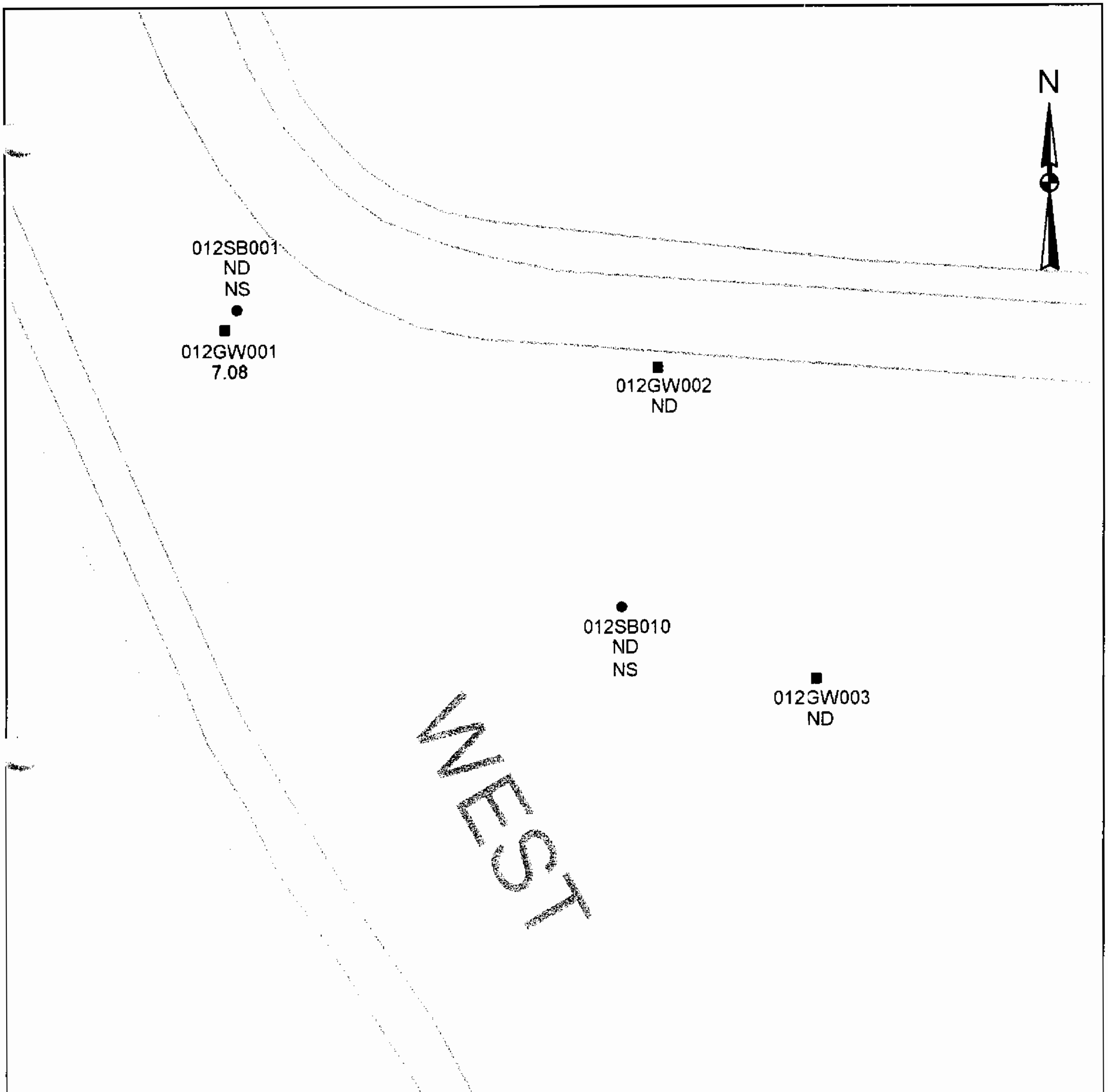
SCALE

20 0 20 40 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.11.6
ZONE I
SWMU 12
123478HxCDF
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=NA RBC=43 NG/KG SSL=216000 NG/KG



LEGEND

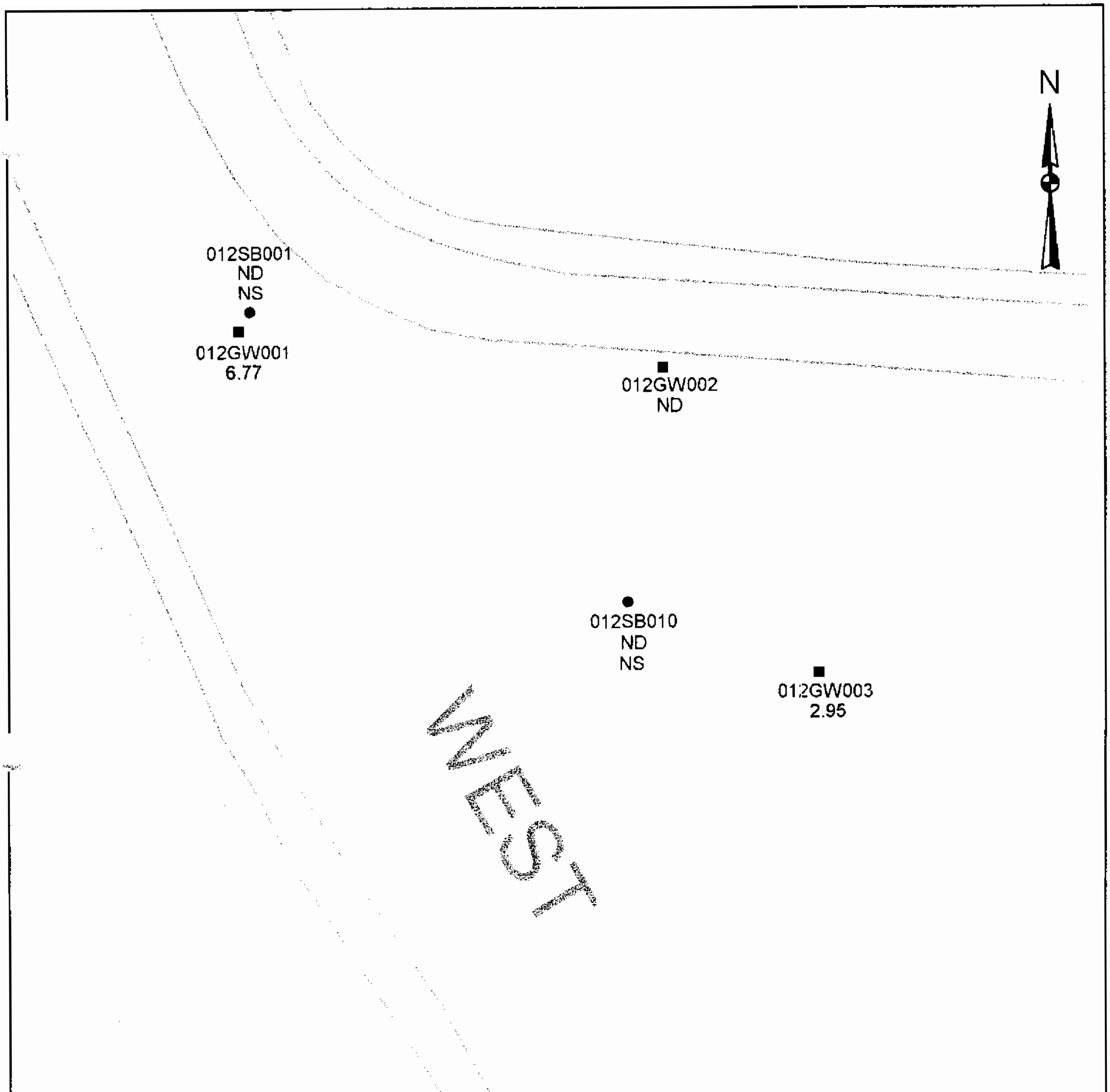
■ MONITORING WELL LOCATION
● ZONE I SOIL BORING LOCATION
12.30 ZONE I SURFACE SOIL CONC. (NG/KG)
12.30 ZONE I SUBSURFACE SOIL CONC. (NG/KG)
12.30 MAXIMUM QUARTERLY GW CONC. (PG/L)
NS NO SAMPLE TAKEN
ND NON DETECT

SCALE
20 0 20 40 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.11.7
ZONE I
SWMU 12
123678HxCDF
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=NA RBC=43 NG/KG SSL=216000 NG/KG



LEGEND

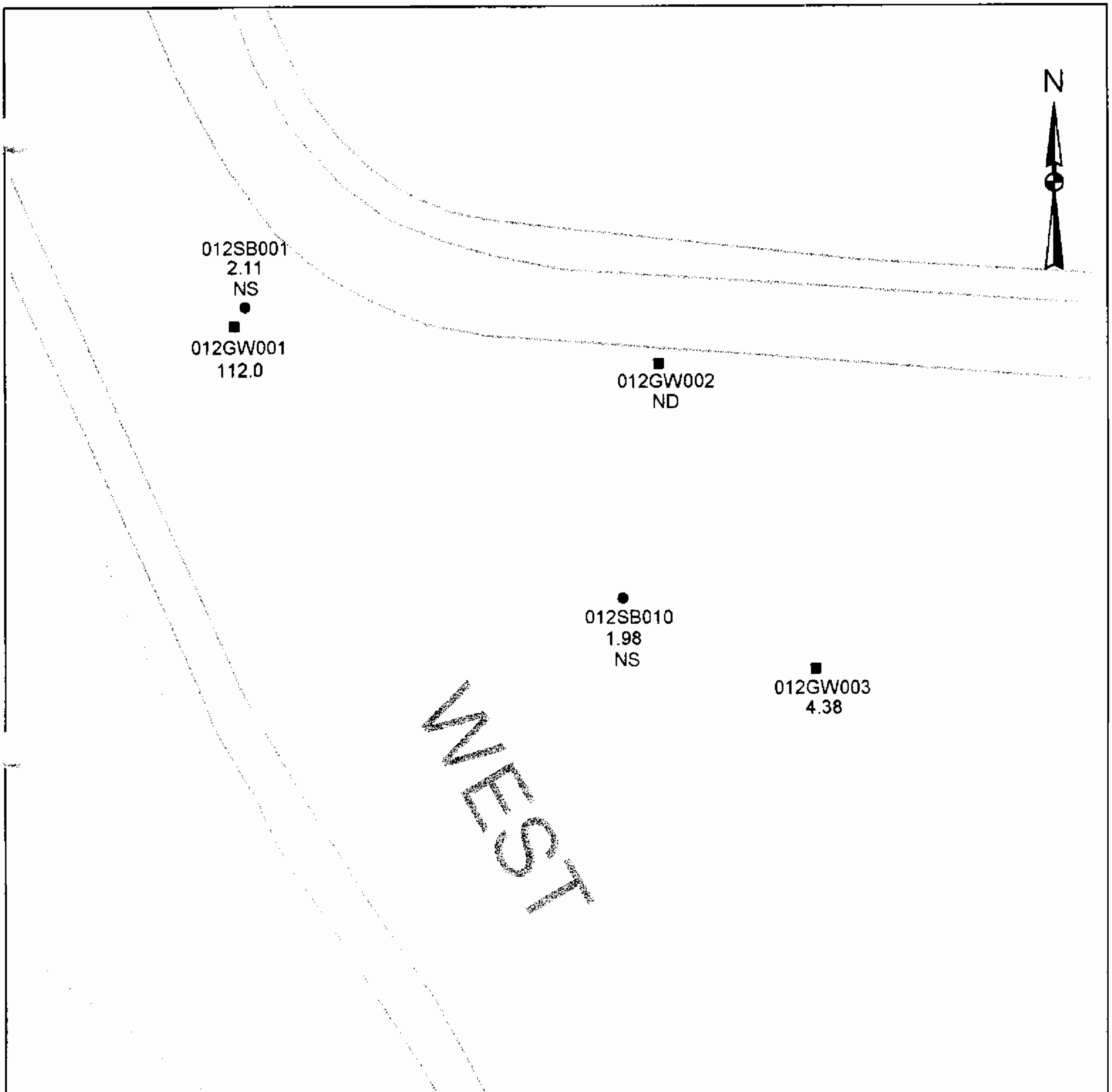
■	MONITORING WELL LOCATION
●	ZONE I SOIL BORING LOCATION
12.30	ZONE I SURFACE SOIL CONC. (NG/KG)
12.30	ZONE I SUBSURFACE SOIL CONC. (NG/KG)
12.30	MAXIMUM QUARTERLY GW CONC. (PG/L)
NS	NO SAMPLE TAKEN
ND	NON DETECT

SCALE
20 0 20 40 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.11.8
ZONE I
SWMU 12
123789HxCDF
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=NA RBC=43 NG/KG SSL=216000 NG/KG



LEGEND

■	MONITORING WELL LOCATION
●	ZONE I SOIL BORING LOCATION
12.30	ZONE I SURFACE SOIL CONC. (NG/KG)
12 30	ZONE I SUBSURFACE SOIL CONC. (NG/KG)
12.30	MAXIMUM QUARTERLY GW CONC. (PG/L)
NS	NO SAMPLE TAKEN
ND	NON DETECT

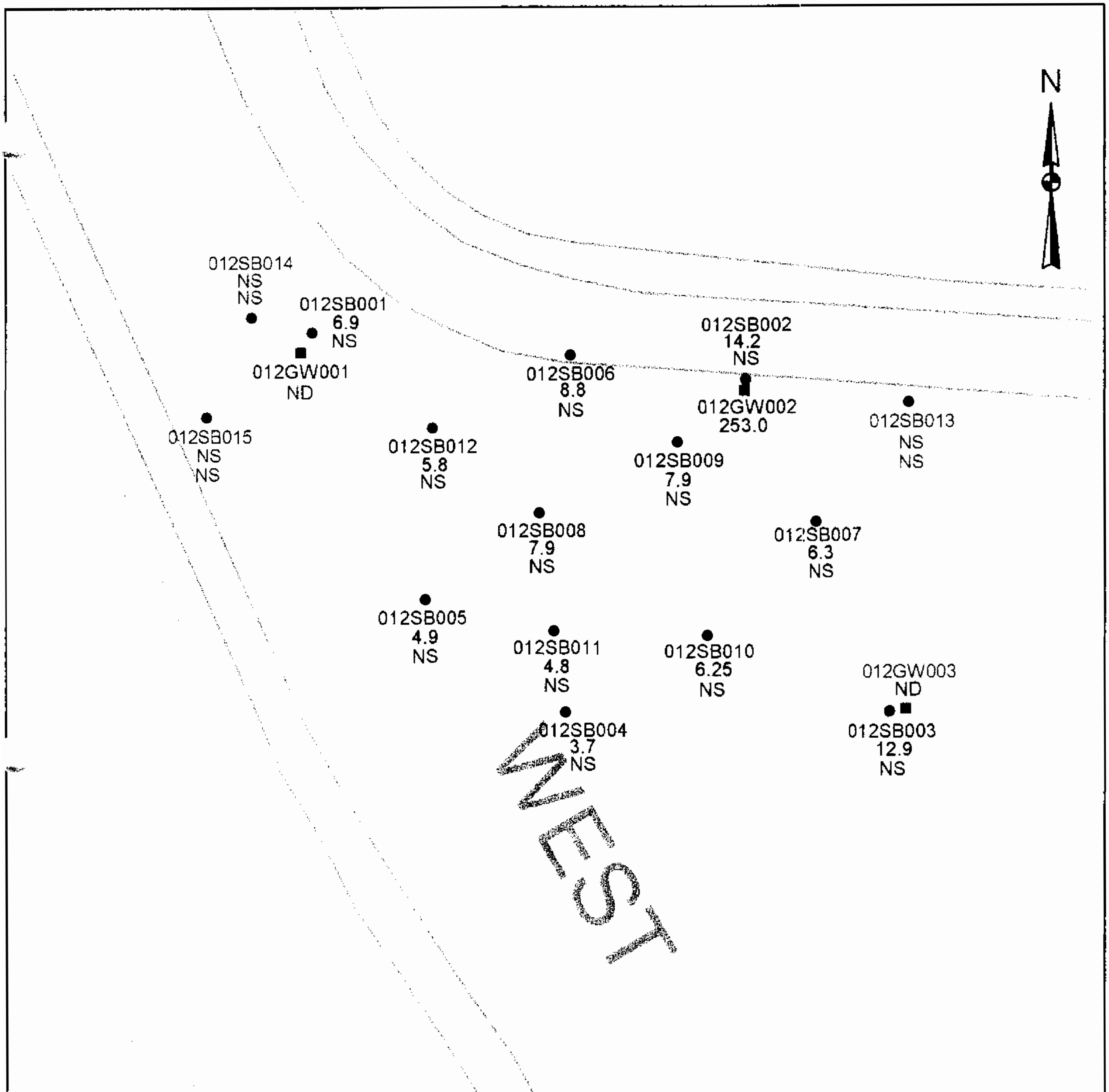
SCALE

20 0 20 40 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.11.9
ZONE I
SWMU 12
1234678HxCDF
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=NA RBC=43 NG/KG SSL=216000 NG/KG



LEGEND

■	MONITORING WELL LOCATION
●	ZONE I SOIL BORING LOCATION
12.30	ZONE I SURFACE SOIL CONC. (MG/KG)
12.30	ZONE I SUBSURFACE SOIL CONC. (MG/KG)
12.30	MAXIMUM QUARTERLY GW CONC. (UG/L)
NS	NO SAMPLE TAKEN
ND	NON DETECT

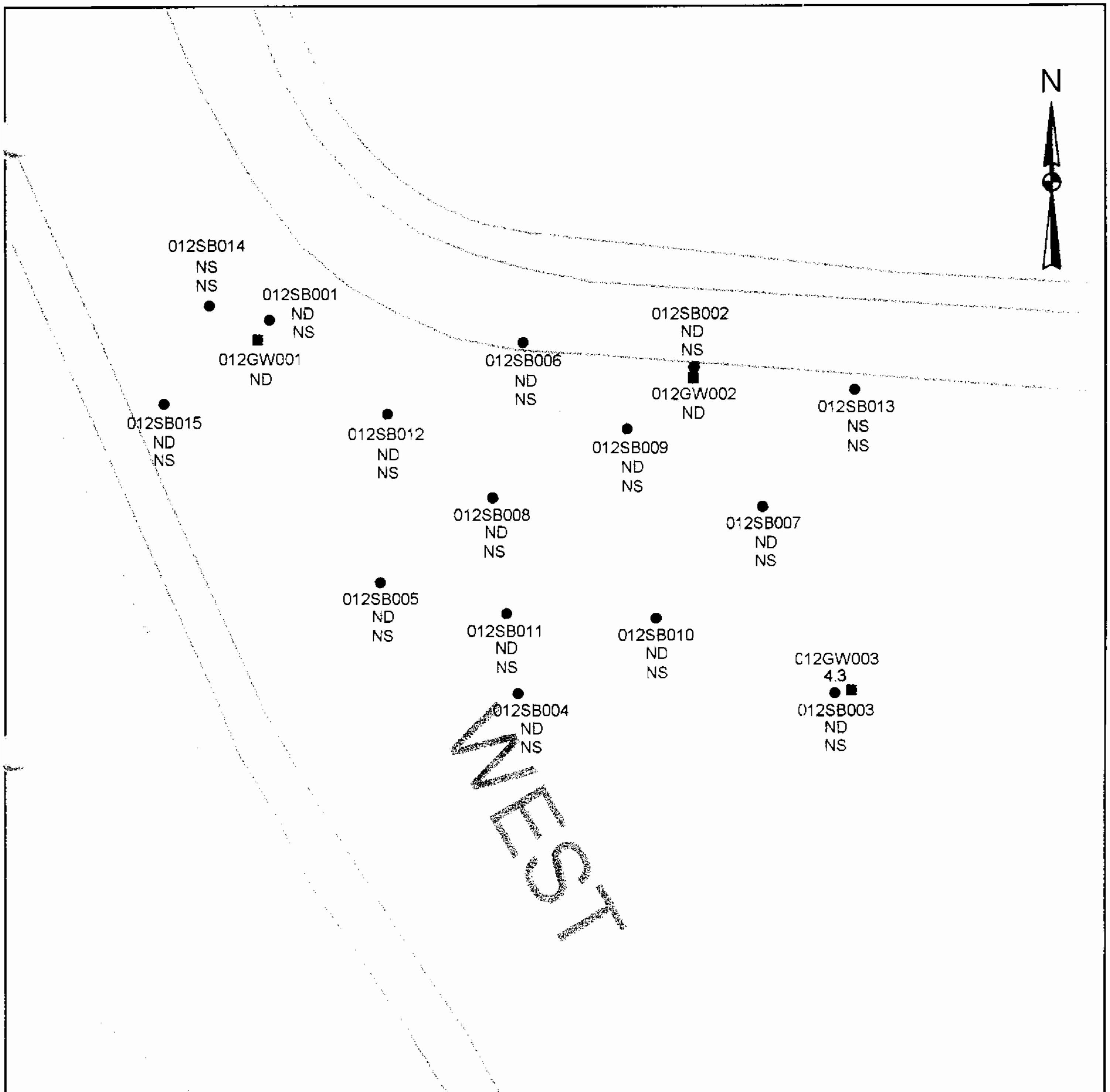
SCALE

20 0 20 40 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.11.10
ZONE I
SWMU 12
ARSENIC
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=50 UG/L RBC=.43 MG/KG SSL=15 MG/KG



LEGEND

■	MONITORING WELL LOCATION
●	ZONE I SOIL BORING LOCATION
12.30	ZONE I SURFACE SOIL CONC. (MG/KG)
12.30	ZONE I SUBSURFACE SOIL CONC. (MG/KG)
12.30	MAXIMUM QUARTERLY GW CONC. (UG/L)
NS	NO SAMPLE TAKEN
ND	NON DETECT

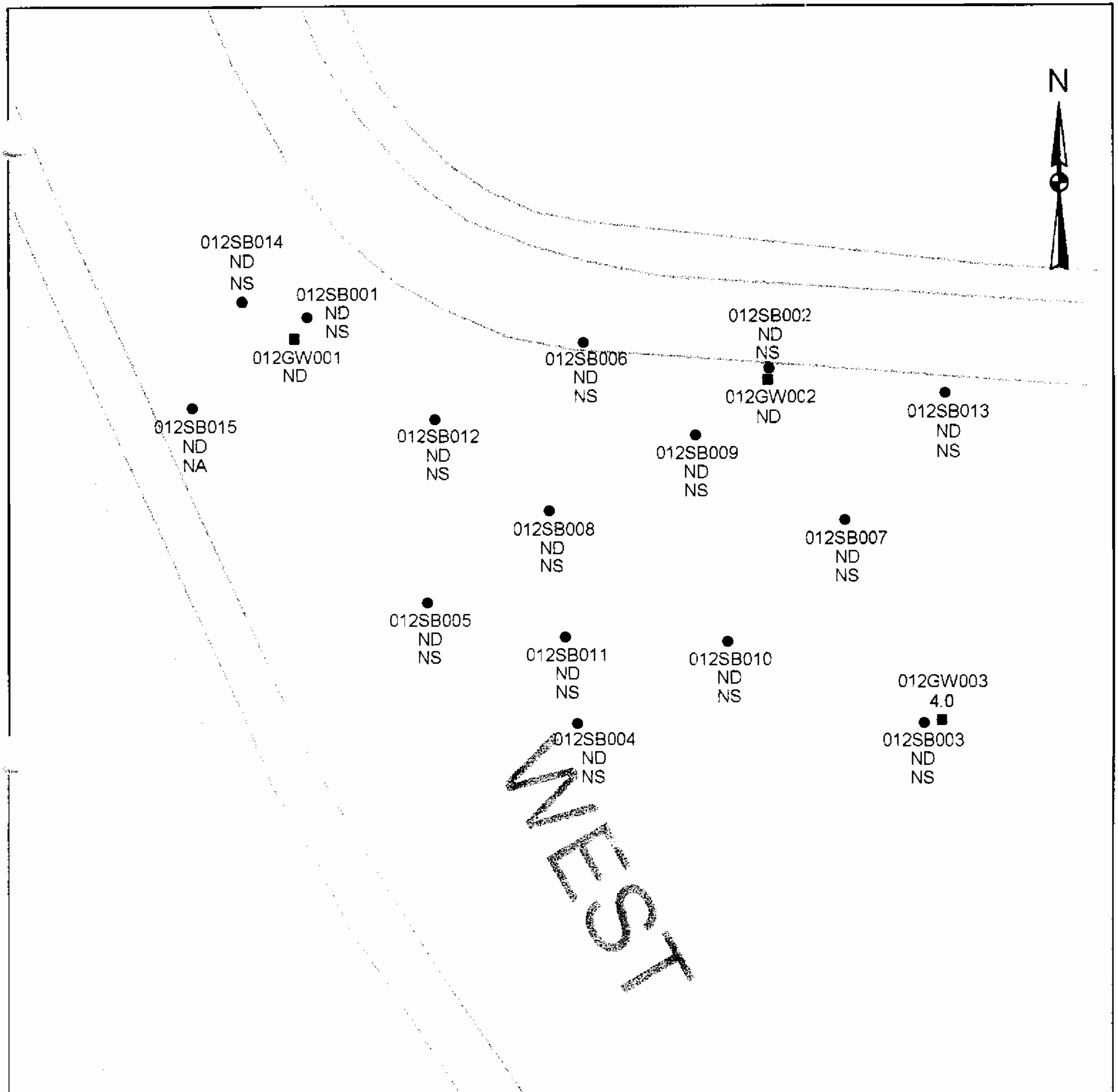
SCALE

20 0 20 40 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.11.11
ZONE I
SWMU 12
THALLIUM
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=2 UG/L RBC=.55 MG/KG SSL=.36 MG/KG



LEGEND

■	MONITORING WELL LOCATION
●	ZONE I SOIL BORING LOCATION
12.30	ZONE I SURFACE SOIL CONC. (UG/KG)
12.30	ZONE I SUBSURFACE SOIL CONC. (UG/KG)
12.30	MAXIMUM QUARTERLY GW CONC. (UG/L)
NS	NO SAMPLE TAKEN
ND	NON DETECT

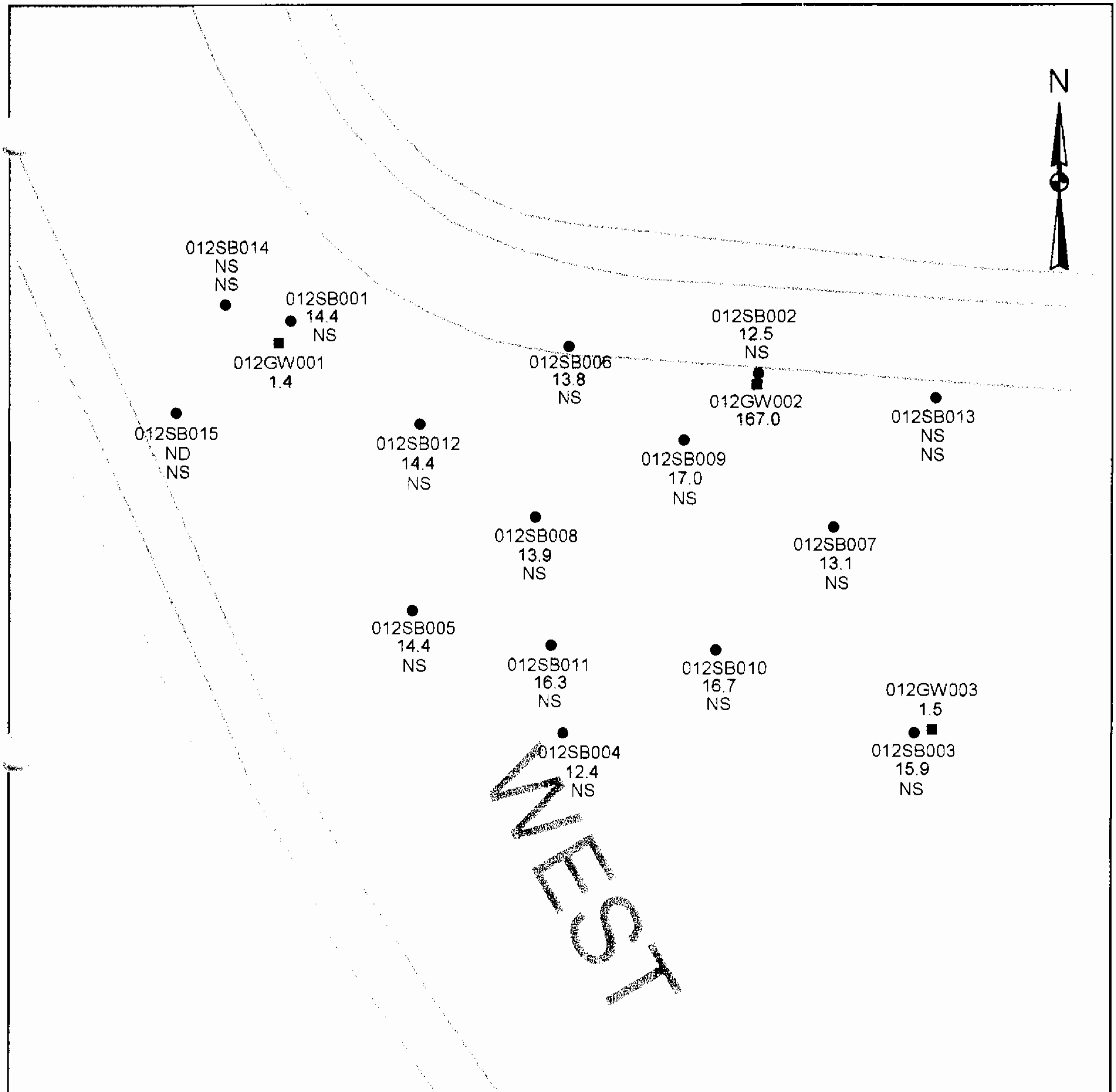
SCALE

20 0 20 40 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.11.12
ZONE I
SWMU 12
DI-N-BUTYLPHTHALATE
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=NA RBC=780000 UG/KG SSL=2300000 UG/KG



LEGEND

■	MONITORING WELL LOCATION
●	ZONE I SOIL BORING LOCATION
12.30	ZONE I SURFACE SOIL CONC. (MG/KG)
12.30	ZONE I SUBSURFACE SOIL CONC. (MG/KG)
12.30	MAXIMUM QUARTERLY GW CONC. (UG/L)
NS	NO SAMPLE TAKEN
ND	NON DETECT

SCALE

20 0 20 40 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.11.13
ZONE I
SWMU 12
NICKEL
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=100 UG/L RBC=160 MG/KG SSL=65 MG/KG

The detections of arsenic and nickel in only one well imply that there is not a large volume of impacted groundwater. Groundwater flow is towards Shipyard Creek and the flowpath length is approximately 600 feet. The significance of these detections to the pathway should be analyzed qualitatively in terms of the dispersive capabilities of the aquifer, the dilutional capacity of the system upon discharge, the likelihood of sources, and persistence of influx downgradient of SWMU 12. In summary, the pathway is valid, but natural mechanisms (such as dilution and dispersion) may attenuate concentrations to insignificant levels at the point of discharge.

10.11.5.3 Soil-to-Air Cross-Media Transport

Three VOCs - acetone, chlorobenzene, and toluene - were detected in surface soil. All concentrations were far below their soil-to-air SSLs, so the pathway is not expected to be significant at this site.

10.11.5.4 Fate and Transport Summary

Soil-to-Groundwater Pathway

One organic - beta-BHC - was present in soil above its SSL.

- This compound was present in only one of 12 samples and was not detected in site groundwater.
- The data indicate that there is little mass of this species in soil, and that it is not significant with respect to the soil-to-groundwater pathway.

One inorganic - chromium - was present at concentrations exceeding its SSL.

- Chromium was widely detected in soil, but in all cases was below the zone-specific background.
- Its concentrations in groundwater did not exceed screening levels. Therefore, the soil-to-groundwater pathway for chromium is valid, but is not expected to be significant.

Groundwater Migration and Surface Water Pathway

One SVOC and five dioxin species were detected in groundwater at concentrations above their respective RBCs.

- BEHP was detected above its RBC, but was present in only two of 14 soil samples and was far below its SSL in those samples. This indicates a source other than the site (or an onsite source not determined). It was present in only one of three groundwater samples and only during the fourth-quarter of sampling. Its sporadic occurrence and low concentration suggest that it is not significant with respect to the ingestion pathway, but its persistence in groundwater should be validated with further sampling.
- Of the five dioxin species detected, only OCDD was present in the most recent samples, and their detected concentration was below the RBC. All of the calculated TEQs were either below the SSL or nondetect in site soil. Their absence in site soil suggests a source groundwater other than the site (or an undetermined onsite source). The absence of all but OCDD in the most recent sampling event invalidates the pathway for four of the dioxin species. The pathway for TEQs, while valid, is not expected to be significant.

Two inorganic constituents – arsenic and thallium – were present at levels that exceeded their respective RBCs.

- Arsenic was consistently detected in one well at concentrations well above the RBC. It is also present at relatively low concentrations in site soil. Arsenic is probably not associated with past site activities, but rather with non-native fill or a natural soil/aquifer matrix.
- Thallium was detected in only one well and only during the last quarter of sampling. Thallium is a common component in zone groundwater above the RBC, suggesting a non-point source. It was nondetect in site soil, clearly suggesting a source other than site activities. It is more likely to be associated with non-native fill or natural aquifer matrix.

- The pathway for both inorganics is chemically valid. However, the limited spatial distribution of both, and the inconsistent detection of thallium, suggest that these are not be of great significance with respect to the ingestion pathway.

Three constituents – di-n-butylphthalate, arsenic, and nickel – were present in groundwater above their surface water screening values.

- Di-n-butylphthalate was detected in only one well during the first quarter. It has been nondetect since, invalidating the pathway.
- Both arsenic and nickel significantly exceeded their surface water screening values and background. Each was detected in one well each quarter at a consistent concentration. Chemically, the surface water pathway is valid for these inorganics.
- Hydrologically, the pathway is also valid: groundwater flow is towards Shipyard Creek and the flowpath length is approximately 600 feet. Natural mechanisms such as dilution and dispersion may reduce concentrations to insignificant levels at the point of discharge. This should be validated with empirical data collected from Shipyard Creek.

Soil-to-Air Pathway

Three organics were detected in surface soil, but none exceeded the soil-to-air SSL. Thus, this pathway is not expected to be significant at SWMU 12.

10.11.6 Human Health Risk Assessment

10.11.6.1 Site Background and Investigative Approach

The purpose of the investigation at SWMU 12 was the assessment of soil and groundwater potentially affected by past site activities. SWMU 12 is the former old firefighter training area, a shallow pit into which flammable liquids were pumped, ignited, and then extinguished. A gravel road and clearing, currently used as a construction laydown yard, are reportedly near the former training area location. The principle materials of concern at SWMU 12 are petroleum hydrocarbons, coal ash, boiler clink, and other potential contaminants related to past training exercises and undocumented disposal practices.

Soil was sampled in two rounds at SWMU 12 at the locations shown on Figure 10.11.1. During the first-round of sampling, 12 upper-interval samples were collected and analyzed for the standard suite (VOCs, SVOCs, metals, cyanide, pesticides, and PCBs) and organotins at DQO Level III. One proposed sample location was inaccessible because of construction materials in the laydown yard. No lower-interval samples were collected because the water table was at less than 5 feet bgs. Two samples were collected as duplicates and submitted for Appendix IX analysis, which includes the standard suite plus herbicides, hex-chrome, OP pesticides, and dioxins.

Second-round sampling was performed following comparison of first-round analytical results to the USEPA Region II *Risk-Based Concentration Table*, April 1998. Three additional samples were collected and analyzed for SVOCs at DQO Level III.

To characterize groundwater quality, at SWMU 12, three SWMU 12 shallow monitoring wells were installed sampled in accordance with the approved final RFI work plan. Figure 10.11.1 shows the SWMU 12 monitoring well locations. SWMU 12 wells were sampled in the first-round for VOCs, SVOCs, metals, cyanide, pesticides, PCBs, organotins, hex-chrome, OP pesticides, dioxins, chlorides, TDS, and sulfates at DQO Level III. Second and third-round samples were analyzed from all wells for cyanide, metals, chloride, sulfate, and TDS. Samples from one well were also analyzed for chloride, sulfate, and TDS. Fourth-round samples from all wells were analyzed for the standard suite plus chlorides, TDS, sulfates, and dioxins.

10.11.6.2 COPC Identification

Soil

Based on the screening comparisons described in Section 7 of this RFI and presented in Table 10.11.11 , the focus of this HHRA is on the following COPCs: benzo(a)pyrene equivalents and chromium. Aluminum, arsenic, and manganese were detected at maximum concentrations exceeding their RBCs but not exceeding their respective background concentrations. Therefore, these inorganics were eliminated from further consideration in the HHRA. Wilcoxon rank sum test analyses did not result in the inclusion of any inorganic parameters which were screened out on the basis of background concentrations.

Groundwater

As shown in Table 10.11.12, the following chemicals were identified as COPCs in shallow groundwater at SWMU 12: bis(2-ethylhexyl)phthalate, dioxins (2,3,7,8-TCDD equivalents), arsenic, cadmium, nickel, and thallium. Manganese was detected at a maximum concentration exceeding its RBC, but not exceeding its background concentration. Therefore, manganese was eliminated from further consideration. Wilcoxon rank sum test analyses did not result in the inclusion of any inorganic parameters which were screened out on the basis of background concentrations.

10.11.6.3 Exposure Assessment

Exposure Setting

SWMU 12 is the old firefighter training area. The SWMU is a shallow pit into which flammable liquids were pumped, ignited, and then extinguished. The future use of this SWMU is unknown. Current base reuse plans indicate that the area is slated for use as an open buffer. Since municipal water is readily available basewide, it is highly unlikely that the aquifer will be used as a source

Table 10.11.11
Chemicals Present in Site Samples
SWMU 12 - Surface Soil
Charleston Naval Complex
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration Residential RBC	Screening Concentration Background	Units	Number Exceeding RBC	Number Exceeding Background
Carcinogenic PAHs													
Benzo(a)pyrene Equivalents	*	4	15	0.084	147	40.7	810	1200	87	NA	UG/KG	1	
Benzo(a)anthracene		2	15	60	67	63.5	660	960	870	NA	UG/KG		
Benzo(a)pyrene	*	1	15	100	100	100	660	960	87	NA	UG/KG	1	
Benzo(b)fluoranthene		2	15	90	360	225	770	1100	870	NA	UG/KG		
Benzo(k)fluoranthene		2	15	110	390	250	620	900	8700	NA	UG/KG		
Chrysene		3	15	65	130	93	540	790	87000	NA	UG/KG		
Inorganics													
Aluminum (Al)		12	12	3020	17900	8009	NA	NA	7800	27400	MG/KG	5	
Antimony (Sb)		8	12	0.29	0.49	0.37	0.24	0.47	3.1	ND	MG/KG		
Arsenic (As)		12	12	3.7	14.2	7.53	NA	NA	0.43	21.6	MG/KG	12	
Barium (Ba)		12	12	5.4	27.3	15.2	NA	NA	550	54.2	MG/KG		
Beryllium (Be)		12	12	0.2	0.63	0.35	NA	NA	16	0.95	MG/KG		
Cadmium (Cd)		12	12	0.21	0.46	0.35	NA	NA	7.8	0.61	MG/KG		
Calcium (Ca)	N	12	12	39400	164000	115792	NA	NA	NA	NA	MG/KG		
Chromium (Cr)	*	12	12	23.9	39	30.9	NA	NA	39	34.5	MG/KG	1	2
Chromium (Cr6) (Hexavalent)		1	2	0.415	0.415	0.415	0.01	0.01	39	ND	MG/KG		
Cobalt (Co)		11	12	0.72	3.7	1.79	0.6	0.6	470	5.8	MG/KG		
Copper (Cu)		12	12	10.6	27.7	15.2	NA	NA	310	240	MG/KG		
Iron (Fe)	N	12	12	3040	14900	6512	NA	NA	NA	NA	MG/KG		
Lead (Pb)		12	12	1.8	19.3	7.95	NA	NA	400	203	MG/KG		
Magnesium (Mg)	N	12	12	2710	6140	3527	NA	NA	NA	NA	MG/KG		
Manganese (Mn)		11	12	38.4	286	118	32	32	160	419	MG/KG	3	
Mercury (Hg)		1	12	0.24	0.24	0.24	0.12	0.14	2.3	0.47	MG/KG		
Nickel (Ni)		12	12	12.4	17	14.6	NA	NA	160	23.9	MG/KG		
Potassium (K)	N	12	12	728	1630	1144	NA	NA	NA	NA	MG/KG		
Selenium (Se)		12	12	0.99	1.8	1.43	NA	NA	39	1.49	MG/KG		7
Sodium (Na)	N	12	12	550	2140	1431	NA	NA	NA	NA	MG/KG		
Tin (Sn)		1	12	1.4	1.4	1.4	0.98	1.1	4700	7.5	MG/KG		
Vanadium (V)		12	12	12.9	34.9	21	NA	NA	55	113	MG/KG		
Zinc (Zn)		12	12	23.5	54.6	40	NA	NA	2300	206	MG/KG		

Table 10.11.11
Chemicals Present in Site Samples
SWMU 12 - Surface Soil
Charleston Naval Complex - Zone I
Charleston, South Carolina

Parameter	Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration Residential RBC	Screening Concentration Background	Units	Number Exceeding RBC	Number Exceeding Background
Pesticides												
4,4'-DDE	1	12	0.64	0.64	0.64	4.3	250	1900	NA	UG/KG		
4,4'-DDT	1	12	1.3	1.3	1.3	4.3	250	1900	NA	UG/KG		
beta-BHC	1	12	8	8	8	1.2	70	350	NA	UG/KG		
Endosulfan II	1	12	6.55	6.55	6.55	4.3	250	47000	NA	UG/KG		
Endrin aldehyde	3	12	1.7	3.6	2.52	1.2	70	2300	NA	UG/KG		
Heptachlor epoxide	1	12	4.3	4.3	4.3	1.2	70	70	NA	UG/KG		
Methoxychlor	1	12	1.3	1.3	1.3	4.3	250	39000	NA	UG/KG		
Semivolatile Organics												
bis(2-Ethylhexyl)phthalate (BEHP)	2	15	62	2400	1231	750	1100	46000	NA	UG/KG		
Fluoranthene	3	15	76	81	78.7	920	1300	310000	NA	UG/KG		
Pyrene	3	15	60	180	100	730	1100	230000	NA	UG/KG		
Volatile Organics												
2-Butanone (MEK)	2	12	11	13	12	43	51	4700000	NA	UG/KG		
Acetone	9	12	9	67	34.2	120	130	780000	NA	UG/KG		
Toluene	9	12	2	27	8.83	21	22	1600000	NA	UG/KG		
Organotins												
Tetrabutyltin	2	12	197.9	316.23	257	3.7	5.6	2300	NA	UG/KG		
TCDD Equivalents												
Dioxin	2	2	0.255	0.337	0.296	NA	NA	4.3	NA	NG/KG		

Notes:
* - Indicates chemical was identified as a COPC
N - Indicates chemical is an essential nutrient
SQL - Sample quantitation limit
RBC - Risk-based concentration
UG/KG - micrograms per kilogram
MG/KG - milligrams per kilogram
NG/KG - nanograms per kilogram
NA - Not applicable or not available
ND - Not determined due to lack of information

Table 10.11.12
Chemicals Present in Site Samples
SWMU 12 - Groundwater
Charleston Naval Complex
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration Tap Water RBC	Background	Units	Number Exceeding RBC	Number Exceeding Background
Inorganics													
Aluminum (Al)		1	12	31.9	31.9	31.9	18	25	3700	1440	UG/L		
Arsenic (As)	*	4	12	177	253	210	3.2	7.8	0.045	23	UG/L	4	4
Barium (Ba)		9	12	40.8	139	83.5	48.8	99.2	260	110	UG/L		3
Beryllium (Be)		3	12	0.51	0.8	0.62	0.2	1	7.3	1.1	UG/L		
Cadmium (Cd)	*	3	12	0.3	3.1	1.5	0.3	1	1.8	NA	UG/L	1	
Calcium (Ca)	N	12	12	167000	782000	358000	NA	NA	NA	NA	UG/L		
Chromium (Cr)		4	12	1.2	1.75	1.51	1	3.8	18	14.3	UG/L		
Cobalt (Co)		5	12	0.75	7.2	4.29	0.6	5	220	2.2	UG/L		4
Iron (Fe)	N	12	12	24.6	104000	28743	NA	NA	NA	NA	UG/L		
Lead (Pb)		3	12	1.9	4.9	3.23	1.7	3.9	15	4.4	UG/L		1
Magnesium (Mg)	N	12	12	202000	651000	422583	NA	NA	NA	NA	UG/L		
Manganese (Mn)		12	12	56.5	4920	1354	NA	NA	73	5430	UG/L	9	
Nickel (Ni)	*	5	12	1.5	167	85.9	1	3	73	13.3	UG/L	3	4
Potassium (K)	N	11	12	86800	285000	178773	80000	80000	NA	NA	UG/L		
Selenium (Se)		1	12	6.1	6.1	6.1	2.8	5	18	ND	UG/L		
Sodium (Na)	N	12	12	1270000	4830000	3280833	NA	NA	NA	NA	UG/L		
Thallium (Tl)	*	1	12	4.3	4.3	4.3	2.7	5	0.26	2	UG/L	1	1
Tin (Sn)		4	12	2.9	374	225	2.6	20	2200	NA	UG/L		
Vanadium (V)		6	12	1	10	3.93	0.5	4.3	26	14	UG/L		
Zinc (Zn)		4	12	5.6	47.2	28.6	4	5.3	1100	24.4	UG/L		2
Pesticides													
Endrin aldehyde		1	12	0.03	0.03	0.03	0.03	0.08	1.1	NA	UG/L		
Semivolatile Organics													
Benzoic acid		1	6	1	1	1	50	95	15000	NA	UG/L		
bis(2-Ethylhexyl)phthalate (BEHP)	*	1	6	20	20	20	10	25	4.8	NA	UG/L	1	
Di-n-butylphthalate		1	6	4	4	4	10	15	370	NA	UG/L		
Volatile Organics													
Acetone		1	6	8	8	8	10	15	370	NA	UG/L		
Chlorobenzene		1	6	1	1	1	5	10	3.5	NA	UG/L		

Table 10.11.12
Chemicals Present in Site Samples
SWMU 12 - Groundwater
Charleston Naval Complex
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration Tap Water		Units	Number Exceeding	
									RBC	Background		RBC	Background
Dioxin (TCDD Equivalents)	*	3	5	0.0044	4.50	1.62	9.9	14	0.45	NA	PG/L	1	

Notes:
* - Indicates chemical was identified as a COPC
N - Indicates chemical is an essential nutrient
SQL - Sample quantitation limit
RBC - Risk-based concentration
UG/L - micrograms per liter
PG/L - picograms per liter
NA - Not applicable or not available
ND - Not detected

of potable or process water. Groundwater exposure pathways would not be completed if the municipal water supply is kept in place. As a highly conservative estimate of potential risk/hazard due to groundwater pathways, a residential scenario and an industrial scenario were considered for SWMU 12.

Potentially Exposed Populations

Potentially exposed populations are current and future site workers, hypothetical future site residents, and adolescent trespassers. Future site resident and worker exposure scenarios were addressed quantitatively in this risk assessment. The future site resident scenario was built on the premise that existing features would be removed and replaced with dwellings. The resident child scenario was considered to be conservatively representative of the adolescent trespasser.

The future site worker scenario assumed continuous exposure to surface soils and the use of shallow groundwater as a potable water source. Exposure for current site workers would be less than this because of their limited soil contact and the fact that groundwater is not currently used onsite. Therefore, the future worker scenario is considered to be conservatively representative of current site worker exposure.

Exposure Pathways

Exposure pathways for the site workers are dermal contact and incidental ingestion of surface soils, and ingestion of shallow groundwater through potable use. The exposure pathways for future site residents are the same. In addition, the future site worker scenario assumed continuous exposure to surface soil and groundwater conditions. Uniform exposure was assumed for all sample locations. Table 10.11.13 presents the justification for assessing particular exposure pathways in this HHRA.

Table 10.11.13
SWMU 12
Exposure Pathways Summary

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Current Land Uses			
Current Users (Site Workers)	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	This exposure pathway was considered insignificant compared to the other pathways.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Shallow groundwater is not currently used as a source of potable or non-residential water at SWMU 12.
	Shallow groundwater, Inhalation of volatilized shallow groundwater contaminants	No	Shallow groundwater is not currently used as a source of potable or non-residential water at SWMU 12.
	Soil, Incidental ingestion	No (Qualified)	Future site use is considered conservatively representative of current receptors.
	Soil, Dermal contact	No (Qualified)	Future site use is considered conservatively representative of current receptors.
Future Land Uses			
Future Site Residents (Child and Adult), Future Site Workers	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	This exposure pathway was considered insignificant compared to the other pathways.
	Shallow groundwater, ingestion of contaminants during potable or general use	Yes	Shallow groundwater is not likely to be used as a source of potable or non-residential water at SWMU 12. This pathway was addressed as a conservative measure.
	Shallow groundwater, Inhalation of volatilized contaminants during domestic use	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Soil, Incidental ingestion	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.
	Soil, Dermal contact	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.
	Wild game or domestic animals, Ingestion of tissue impacted by media contamination	No	Hunting/taking of game and/or raising livestock is prohibited within the Charleston, South Carolina city limits.
	Fruits and vegetables, Ingestion of plant tissues grown in media	No	The potential for significant exposure via this pathway is low relative to that of other exposure pathways assessed.

Exposure Point Concentrations

Soil

As discussed in Section 7 of this RFI, UCLs were calculated for datasets consisting of least 10 samples. For benzo(a)pyrene equivalents, a hot-spot approach to account for the limited extent of identified impacts involved applying the maximum concentration of the COPC as the EPC. BEQs were detected in four of 15 surface soil samples (012SB002, 012SB006, 012SB007, and 012SB014), with a maximum concentration of 0.147 mg/kg. The other three, surface soil samples contained less than 0.02 mg/kg BEQs. A fraction ingested/ fraction contacted factor (FI/FC) was derived to account for the limited areal extent of BEQs in surface soil. This factor was conservatively estimated to be 0.3, based upon frequency of detection and the approximate size of the impacted area. This FI/FC factor indicates that the concentration reported at 012SB014 represents soil quality over 30 percent of the potential exposure area. This factor was used to adjust the EPC for BEQs.

Chromium was detected all of 12 surface soil samples. Because the UCL did not exceed the maximum reported concentration, the UCL was applied as the EPC to estimate soil-related exposures. The benzo(a)pyrene equivalents and chromium EPCs for surface soil are presented in Table 10.11.14.

Groundwater

Table 10.11.15 summarizes the determination of the groundwater EPC. Three shallow monitoring wells were installed at SWMU 12 and sampled once a quarter for four quarters. Current EPA guidance favors using the arithmetic mean in the most concentrated area of the plume as the EPC for groundwater COPCs. Groundwater COPCs cannot be associated with a single distinct plume; instead, each of the COPCs was assigned to its own "plume". A separate plume is defined by the monitoring well which produced the highest concentration for a given COPC. The EPC is calculated as the arithmetic mean of the four quarters of data from the same well.

Table 10.11.14
Statistical Analysis of COPCs in Surface Soil
SWMU 12
Charleston Naval Complex
Charleston, South Carolina

COPC	n	Natural Log Transformed mean	SD	H-stat	UCL (mg/kg)	MAX (mg/kg)	EPC (mg/kg)	
Benzo(a)pyrene Equivalents	15	-0.196	0.155	1.782	0.90	0.15	0.15	MAX
Chromium	12	3.421	0.148	1.808	33.5	39	33.5	UCL

Notes:
mean arithmetic mean of the logtransformed data
n number of samples analyzed
SD standard deviation for a sample of data
H-stat "H" statistic from Gilbert 1987; cuboidal interpolation was used to determine the value in accordance with *USEPA Supplemental Guidance to RAGS*, Calculating the Concentration Term
EPC exposure point concentration
UCL 95 percentile upper confidence level mean
MAX maximum reported concentration

Table 10.11.15
Statistical Analysis of COPCs in Groundwater
SWMU 12
Charleston Naval Complex
Charleston, South Carolina

		Natural Log Transformed			Mean in	UCL	MAX	EPC	
COPC	n	mean	SD	H-stat	Plume (mg/L)	(mg/L)	(mg/L)	(mg/L)	
Arsenic	12	-4.575	2.231	5.471	0.21	4.92	0.25	0.21	MEAN
Cadmium	12	-7.699	0.797	2.565	0.00124	0.00115	0.0031	0.00124	MEAN
Nickel	12	-5.579	2.442	5.939	0.11	5.91	0.17	0.11	MEAN
Thallium	12	-6.075	0.302	1.929	0.00290	0.00287	0.0043	0.00290	MEAN
bis(2-Ethylhexyl)phthalate	6	NA	NA	NA	0.013	NA	0.020	0.013	MEAN
2,3,7,8-TCDD Equivalents	5	NA	NA	NA	NA	NA	4.5E-09	4.5E-09	MAX

Notes:

mean arithmetic mean of the logtransformed data
n number of samples analyzed
SD standard deviation for a sample of data
H-stat "H" statistic from Gilbert 1987; cuboidal interpolation was used to determine the value in accordance with USEPA Supplemental Guidance to RAGS, Calculating the Concentration Term
NA not applicable
EPC exposure point concentration
UCL 95 percentile upper confidence level mean
MAX maximum reported concentration

For example, the maximum arsenic detection (0.253 mg/L) was from monitoring well 012002 sampled in the fourth-quarter. The first-quarter sample from this monitoring well had an arsenic at a concentration of 0.177 mg/L; the second-quarter sample, of 0.22 mg/L; and the third-quarter sample, 0.188 mg/L. The data from the four quarters yield an average of 0.2095 mg/L, which was used as the EPC for arsenic. The same approach was used for cadmium, nickel, thallium, bis(2-ethylhexyl)phthalate.

The maximum detected concentration of dioxin (TCDD equivalents) was used as its EPC since it was sampled only twice for monitoring well 012001, and since one-half of its SQL exceeded its maximum detected concentration.

Quantification of Exposure

Soil

CDIs for ingestion and dermal contact with soils are shown in Tables 10.11.16 and 10.11.17, respectively.

Groundwater

CDI for each shallow groundwater COPC are presented in Table 10.11.18.

10.11.6.4 Toxicity Assessment

Toxicity assessment terms and methods are discussed in Section 7 of this report. Table 10.11.19 presents toxicological information specific to each COPC identified. This information was used in the quantification of risk/hazard associated with soil and groundwater contaminants. Brief toxicological profiles for each COPC are provided in the following paragraphs.

Table 10.11.16
Chronic Daily Intakes (CDI)
Incidental Ingestion of Surface Soil
SWMU 12
Charleston Naval Complex
Charleston, South Carolina

Chemical	Fraction Ingested from Contaminated Source*	Exposure Point Concentration (mg/kg)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future ResidentLWA C-CDI (mg/kg-day)	Future Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Benzo(a)pyrene Equivalents	0.3	0.15	6.04E-08	5.64E-07	6.90E-08	2.16E-08	7.71E-09
Chromium	1	33.5	4.59E-05	4.29E-04	5.25E-05	1.64E-05	5.86E-06

Notes:
LWA Llifetime-weighted average; used to calculate carcinogenic CDI, *RAGS Parts A and B.*
CDI Chronic daily intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
* Reflects the estimated fraction of the site impacted by the corresponding COPC.

Table 10.11.17
Chronic Daily Intakes
Dermal Contact with Surface Soil (0-1')
SWMU 12
Charleston Naval Complex
Charleston, South Carolina

Chemical	Exposure Point Concentration (mg/kg)	Fraction Contacted from Contaminated Source *	Dermal Absorption Factor+ (unitless)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident LWA C-CDI (mg/kg-day)	Future Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Benzo(a)pyrene Equivalents	0.15	0.3	0.01	2.48E-08	8.18E-08	1.55E-08	1.77E-08	6.32E-09
Chromium	33.5	1	0.001	1.88E-06	6.22E-06	1.18E-06	1.35E-06	4.80E-07

Notes:
CDI Chronic daily intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
\+ The dermal absorption factor was applied to the exposure point concentration to reflect the different trans-dermal migration of inorganic versus organic chemicals
* Reflects the estimated fraction of the site impacted by the corresponding COPC.
LWA Lifetime-weighted average

Table 10.11.18
Chronic Daily Intakes
Ingestion/Inhalation of COPCs in Shallow Groundwater
SWMU 12
Charleston Naval Complex
Charleston, South Carolina

Chemical	Exposure Point Concentration (mg/liter)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident LWA C-CDI (mg/kg-day)	Future Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Arsenic	0.21	5.74E-03	1.34E-02	3.16E-03	2.05E-03	7.32E-04
Cadmium	0.00124	3.40E-05	7.93E-05	1.87E-05	1.21E-05	4.33E-06
Nickel	0.11	2.93E-03	6.84E-03	1.61E-03	1.05E-03	3.74E-04
Thallium	0.00290	7.95E-05	1.85E-04	4.37E-05	2.84E-05	1.01E-05
bis(2-Ethylhexyl)phthalate (BEHP)	0.013	3.42E-04	7.99E-04	1.88E-04	1.22E-04	4.37E-05
Dioxin (TCDD Equivalents)	4.5E-09	1.23E-10	2.88E-10	6.78E-11	4.40E-11	1.57E-11

Notes:
LWA Lifetime-weighted average
CDI Chronic daily intake
H-CDI Non-carcinogenic hazard based CDI
C-CDI Carcinogenic risk based CDI

Table 10.11.19
Toxicological Reference Information
for Chemicals of Potential Concern
SWMU 12
Charleston Naval Complex
Charleston, South Carolina

	Non-Carcinogenic Toxicity Data								Carcinogenic Toxicity Data			
Chemical	Oral Reference Dose (mg/kg-day)	Confidence Level	Critical Effect	Uncertainty Factor Oral	Inhalation Reference Dose (mg/kg-day)	Confidence Level	Critical Effect	Uncertainty Factor Inhalation	Oral Slope Factor (kg-day/mg)	Inhalation Slope Factor (kg-day/mg)	Weight of Evidence	Tumor Type
Arsenic	0.0003 a	M	hyperpigmentation	3	NA	NA	NA	NA	1.5 a	15.1 a	A	various
BEQ	NA	NA	NA	NA	NA	NA	NA	NA	7.3 a	3.1 c	B2	mutagen
bis(2-Ethylhexyl)phthalate	0.02 a	M	increased liver weight	1,000	NA	NA	NA	NA	0.014 a	0.014 c	B2	hepatoma
Cadmium (water)	0.0005 a	H	proteinuria	10	NA	NA	NA	NA	NA	6.3 a	B1	lung
Chromium III	1 a	L	NA	100/10	NA	NA	NA	NA	NA	NA a	D	NA
Chromium VI	0.005 a	L	NA	500	1E-07 c	NA	NA	NA	NA	41 b	A	lung
Nickel	0.02 a	M	decreased body and organ weight	300	NA	NA	NA	NA	NA	NA	D	NA
Thallium	7E-05 d	L	increased SGOT (liver) increased serum LDH	3000	NA	NA	NA	NA	NA	NA	D	NA
Dioxin (TCDD Equivalents)	NA	NA	NA	NA	NA	NA	NA	NA	150,000 b	150,000 b	B2	mutagen and teratogen

Notes:

a = Integrated Risk Information System (IRIS)
b = Health Effects Assessment Summary Tables (HEAST)
c = EPA NCEA - Cincinnati (provisional)
d = RfDo for thallium sulfate corrected for the difference in molecular weight between thallium and thallium sulfate
NA = Not applicable or not available
H = High confidence
L = Low confidence
M = Medium confidence

Arsenic exposure via the ingestion route causes darkening and hardening of the skin in chronically exposed humans. Inhalation exposure to arsenic causes neurological deficits, anemia, and cardiovascular effects (Klaasen, et al., 1986). USEPA set 0.3 μg/kg-day as the RfD for arsenic based on a NOAEL of 0.8 μg/kg-day in a human exposure study. The effects of the arsenic on the nervous and cardiovascular systems are primarily associated with acute exposure to higher levels. Exposure to arsenic-containing materials has been shown to cause cancer in humans. Inhalation of these materials can lead to increased lung cancer risk, and ingestion of these materials is associated with increased skin cancer rates.

Arsenic has been classified as a group A carcinogen by USEPA, which established the 1.5 (mg/kg-day)$^{-1}$ SF. As listed in IRIS, the basis for the classification is sufficient evidence from human data. An increased lung cancer mortality was observed in multiple human populations exposed primarily through inhalation. Also, increased mortality from multiple internal organ cancers (liver, kidney, lung, and bladder) and an increased incidence of skin cancer were observed in populations consuming drinking water high in inorganic arsenic. Human milk contains about 3 μg/L arsenic. The tap-water RBC for arsenic is 0.045 μg/L. As listed in IRIS, the critical effects of this chemical are hyperpigmentation, keratosis, and possible vascular complications. The uncertainty factor was determined to be 3 and the modifying factor was determined to be 1.

Benzo(a)pyrene equivalents include the following polynuclear aromatic hydrocarbons (PAHs):

Benzo(a)anthracene	TEF 0.1
Benzo(a)pyrene	TEF 1.0
Benzo(b)fluoranthene	TEF 0.1
Benzo(k)fluoranthene	TEF 0.01
Chrysene	TEF 0.001
Dibenz(a,h)anthracene	TEF 1.0
Indeno(1,2,3-cd)pyrene	TEF 0.1

Some PAHs are toxic to the liver, kidney, and blood. However, the toxic effects of the listed PAHs have not been well established and there are no RfDs for these PAHs due to a lack of data. All PAHs listed above are classified by USEPA as B2 carcinogens, and their carcinogenicity is addressed relative to that of benzo(a)pyrene, which has an oral SF of 7.3 $(mg/kg\text{-}day)^{-1}$. TEFs, also set by USEPA, are multipliers applied to the detected concentrations, which are subsequently used to calculate excess cancer risk. These multipliers are discussed further in the exposure and toxicity assessment sections. Most carcinogenic PAHs have been so classified due to animal studies using large doses of purified PAHs. There is some doubt as to the validity of these listings, and the SFs listed in USEPA's RBC table are provisional. However, these PAHs are carcinogens when the exposure involves a mixture of other carcinogenic substances (e.g., coal tar, soot, or cigarette smoke). As listed in IRIS, human data that specifically link benzo(a)pyrene to a carcinogenic effect are lacking. There are, however, multiple animal studies in many species demonstrating benzo(a)pyrene to be carcinogenic by numerous routes.

Benzo(a)pyrene has produced positive results in numerous genotoxicity assays. At the June 1992 CRAVE Work Group meeting, a revised risk estimate of benzo(a)pyrene was verified. This section provides information on the aspects of the carcinogenic risk assessment for the agent in question: the USEPA classification and quantitative estimates of exposure. The classification reflects a weight-of-evidence judgment of the likelihood that the agent is a human carcinogen. The quantitative risk estimates are presented in application of a low-dose extrapolation procedure and presented as the risk per mg/kg-day. The unit risk is the quantitative estimate in terms of either risk per $\mu g/L$ drinking water or risk per $\mu g/m^3$ air breathed. The third form in which risk is presented is drinking water or air concentration providing cancer risks of 1 in 10,000 or 1 in 1,000,000. The carcinogenicity background document provides details on the carcinogenicity values found in IRIS. Users are referred to the Oral Reference Dose and Reference Concentration sections for information on long-term toxic effects other than carcinogenicity.

As listed in IRIS, the basis for the dibenz(a,h)anthracene and benzo(b)fluoranthene B2 classification is no human data and sufficient data from animal bioassays. Benzo(b)fluoranthene produced tumors in mice after lung implantation, intraperitoneal or subcutaneous injection, and skin painting. As listed in IRIS, the basis for the benzo(a)anthracene B2 classification is no human data and sufficient data from animal bioassays. Benzo(a)anthracene produced tumors in mice exposed by gavage; intraperitoneal, subcutaneous or intramuscular injection; and topical application. Benzo(a)anthracene produced mutations in bacteria and in mammalian cells, and transformed mammalian cells in culture. As listed in IRIS, the basis for the benzo(k)fluoranthene B2 classification is no human data and sufficient data from animal bioassays. Benzo(k)fluoranthene produced tumors after lung implantation in mice and when administered with a promoting agent in skin-painting studies. Equivocal results have been found in a lung adenoma assay in mice. Benzo(k)fluoranthene is mutagenic in bacteria. (Klaasen, et al., 1986).

bis(2-Ethylhexyl)phthalate, known as BEHP, is a plasticizer used in virtually every major product category. Phthalate esters are ubiquitously distributed in the environment. Although the toxicity of this compound is relatively low, it is a carcinogen. Effects on the reproductive system are also possible (indicated in animal studies) due to chronic exposure to BEHP. This compound is classified as a B2 carcinogen, and USEPA has set the oral RfD and oral SF to 0.02 mg/kg-day and 0.014 $(mg/kg\text{-}day)^{-1}$, respectively (Klaasen et al., 1986).

Cadmium can upset the stomach, leading to vomiting and diarrhea in acute exposure; acute inhalation of cadmium-containing dust can irritate the lungs. Chronic exposure to cadmium, either via inhalation or ingestion, has been shown to cause kidney damage (including kidney stones), emphysema, and high blood pressure. Other tissues reportedly injured by cadmium exposure in animals and humans include the lungs, testes, liver, immune system, blood, and nervous system (Klaasen et al., 1986). An oral RfD of 0.001 (mg/kg-day) has been determined by USEPA based on human studies (food) involving chronic exposure in which significant increased protein was found in the urine. A separate oral RfD for water has been determined by USEPA to be 0.0005 mg/kg-day.

For inhalation exposure, cadmium has been classified by USEPA as a group B1, or probable, human carcinogen based on limited evidence from epidemiological studies in which an excess risk of lung cancer was observed in cadmium smelter workers. As listed in IRIS, the classification is based on limited evidence from occupational epidemiologic studies consistent across investigations and study populations. There is sufficient evidence of carcinogenicity in rats and mice by inhalation and intramuscular and subcutaneous injection. There is also sufficient evidence of increased risk of lung cancer in rats and mice exposed to cadmium via inhalation. Seven rat and mice studies where cadmium salts (acetate, sulfate, chloride) were administered orally have shown no evidence of carcinogenic response. As listed in IRIS, the critical effect of this chemical in water is significant proteinuria. The uncertainty factor was 10 and the modifying factor was 1. The critical effect of this chemical in food is based on human studies involving chronic exposures. The uncertainty factor was 10 and the modifying factor was 1.

Chromium exists in two stable, natural forms: CrIII and hexavalent CrVI. Acute exposure to chromium can result in kidney damage following oral exposure, or damage to the nasal mucosa and septum following inhalation exposure. Chronic inhalation exposure to CrVI has resulted in kidney and respiratory tract damage, as well as excess lung cancer in both animals and humans following occupational exposure. Only CrVI is believed to be carcinogenic by inhalation (IRIS). Oral RfD values for CrIII and CrVI are 1.0 and 5E-03 mg/kg-day, respectively. For CrVI, the RfD is based on liver toxicity in rats. For CrVI, the RfD is based on unspecified pathological changes observed in rat studies. In addition, CrVI is considered a group A carcinogen for inhalation exposures, and an inhalation SF of 41 $(mg/kg\text{-}day)^{-1}$ has been established for the hexavalent form. Vitamin supplements contain approximately 0.025 mg of chromium. As listed in IRIS, no critical effects were observed for CrIII. The uncertainty factor was 100 and the modifying factor was 10. As listed in IRIS, no critical effects were observed for CrVI. The uncertainty factor was 500 and the modifying factor was 1.

Nickel is an essential nutrient; a five microgram dose is typical of vitamins supplements. USEPA set the oral RfD to 0.02 mg/kg-day. Chronic exposure of rats to nickel caused decreased body and organ weights. For a chronically exposed individual, nickel salts would affect the gastro-intestinal system and also target the liver and kidney. This element has been shown to be a sensitizer, an element that can produce allergic reactions. Sensitization of skin to nickel dust has been shown to occur in industry (Dreisbach, et al., 1987).

Thallium is readily absorbed through the gut and skin. Primary effects are stomach and bowel disturbances, kidney and liver damage, and neurological disturbances. Thallium was used in the past as a rodenticide and ant killer, uses now prohibited. This element remains in the body for a relatively long time and could accumulate if the chronic dose is large. USEPA's oral RfD for thallium is 8E-05 mg/kg-day (Klaasen, et al., 1986; Dreisbach, et al., 1987). The uncertainty factor used for thallium is 3,000.

Dioxins are a group of chlorinated hydrocarbons that accumulate in fat tissue. Exposure to dioxins, known to be potent mutagens and teratogens, causes burning pain in the tongue, abdomen, and pharynx; chloracne; loss of body weight; degenerative changes to the liver and thymus; and psychiatric disturbances. Chloracne is the primary sign of human exposure (Klaasen, et al., 1986; Dreisbach, et al., 1987). USEPA has classified dioxins as group B2 carcinogens and determined the oral SF to be 150,000 $(mg/kg\text{-}day)^{-1}$ for 2,3,7,8-TCDD. Equivalent concentrations of other dioxin congeners were calculated based on their corresponding toxic equivalents, as recommended by USEPA.

10.11.6.5 Risk Characterization

Surface Soil Pathways

Exposure to surface soil was evaluated under both future residential and industrial (site worker) scenarios. For each scenario, the incidental ingestion and dermal contact exposure pathways were evaluated. For non-carcinogenic contaminants evaluated for future site residents, hazard was computed separately to address child and adult exposures. Tables 10.11.20 and 10.11.21 present the computed carcinogenic risks and/or HQs associated with the incidental ingestion of and dermal contact with site surface soils, respectively.

The site surface cover ranges from lightly vegetated (with bare ground visible) to wooded. A gravel driveway leads to the existing laydown yard. Although construction workers do have occasion to work onsite, the frequency of these activities is considerably lower than assumed in the future worker risk/hazard characterization. Should the existing site features and uses remain under future use scenarios, the soil risk/hazard projections presented below are significant overestimates.

Hypothetical Site Residents

The ingestion ILCR (based on the adult and child lifetime-weighted average) for SWMU 12 surface soils is 5E-07. The dermal pathway ILCR is 2E-07. Benzo(a)pyrene equivalents were the sole contributor for each pathway. Surface soil incidental ingestion and dermal contact pathway hazard indices were less than 0.1 for both adult and child receptors.

Future Site Workers

Site worker ILCRs are 6E-08 and 9E-08 for the ingestion and dermal contact pathways, respectively. Benzo(a)pyrene equivalents were the sole contributor for each pathway. Surface soil incidental ingestion and dermal contact pathway hazard indices were less than 0.01 for site workers.

Table 10.11.20
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
SWMU 12
Charleston Naval Complex
Charleston, South Carolina

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used $(mg/kg\text{-}day)^{-1}$	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident lLWA ILCR	Future Worker adult Hazard Quotient	Future Worker adult ILCR
Benzo(a)pyrene Equivalents	NA	7.3	ND	ND	5.0E-07	ND	5.6E-08
Chromium	5E-03	NA	0.0092	0.086	ND	0.0033	ND
SUM Hazard Index/ILCR			0.009	0.09	5E-07	0.003	6E-08

Notes:
NA Not available
ND Not determined due to lack of available information
LWA Lifetime-weighted average; used to calculate excess carcinogenic risk derived from *RAGS Part A*.
ILCR Incremental lifetime excess cancer risk

Table 10.11.21
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
SWMU 12
Charleston Naval Complex
Charleston, South Carolina

Chemical	Dermal Adjustment	Oral RfD Used (mg/kg-day)	Oral SF Used $(mg/kg\text{-}day)^{-1}$	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident lwa ILCR	Future Worker adult Hazard Quotient	Future Worker adult ILCR
Benzo(a)pyrene Equivalents	0.5	NA	14.6	ND	ND	2.3E-07	ND	9.2E-08
Chromium	0.2	0.001	NA	0.0019	0.0062	ND	0.0013	ND
SUM Hazard Index/ILCR				0.002	0.006	2E-07	0.001	9E-08

Notes:

NA Not available

ND Not determined due to lack of available information

LWA Lifetime-weighted average; used to calculate excess carcinogenic risk derived from *RAGS Part A*.

ILCR Incremental Lifetime excess Cancer Risk

- Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)

Groundwater Pathways

Exposure to shallow groundwater was evaluated under both residential and industrial scenarios. The ingestion and inhalation exposure pathways were evaluated assuming the site groundwater will be used for potable and/or domestic purposes and that an unfiltered well, drawing from the corresponding water-bearing zone, will be installed. For non-carcinogenic contaminants evaluated relative to future site residents, hazard was computed separately for child and adult receptors. Table 10.11.22 presents the risk and hazard for the ingestion exposure pathways. Since no VOCs were identified as COPCs in groundwater at SWMU 12, the inhalation pathway was not addressed.

Hypothetical Site Residents

The sum ILCR for the shallow groundwater ingestion pathway is 5E-03. Arsenic, bis(2-ethylhexyl)phthalate, and 2,3,7,8-TCDD equivalents were the principle contributors. The hazard indices for the adult and child resident ingestion pathway are 20 and 48, respectively. Thallium and arsenic were primary contributors, and cadmium and nickel were minor contributors.

Future Site Workers

The sum ILCR for the shallow groundwater ingestion pathway is 1E-03. Arsenic, bis(2-ethylhexyl)phthalate, and 2,3,7,8-TCDD equivalents were the principle contributors. The hazard index for the site worker ingestion pathway is 7. Thallium and arsenic were primary contributors to the ingestion pathway hazard index.

Current Site Workers

Shallow groundwater is not currently used as a potable water source for SWMU 12 or other areas of Zone I. In the absence of a completed exposure pathway, no threat to human health is posed by reported shallow groundwater contamination.

Table 10.11.22
Hazard Quotients and Incremental Lifetime Cancer Risks
Shallow Groundwater Ingestion
SWMU 12
Charleston Naval Complex
Charleston, South Carolina

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used $(mg/kg\text{-}day)^{-1}$	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident LWA ILCR	Future Worker adult Hazard Quotient	Future Worker adult ILCR
Arsenic	3E-04	1.5	19.13	44.64	4.7E-03	6.83	1.1E-03
Cadmium	5E-04	NA	0.068	0.16	ND	0.024	ND
Nickel	2E-02	NA	0.15	0.34	ND	0.052	ND
Thallium	7E-05	NA	1.14	2.65	ND	0.41	ND
bis(2-Ethylhexyl)phthalate (BEHP)	2E-02	1.40E-02	0.017	0.040	2.6E-06	0.0061	6.1E-07
Dioxin (TCDD Equivalents)	NA	1.50E+05	ND	ND	1.0E-05	ND	2.4E-06
SUM Hazard Index/ILCR			20	48	5E-03	7	1E-03

Notes:
NA Not available
ND Not determined due to lack of available information
LWA Lifetime-weighted average; used to calculate excess carcinogenic risk derived from *RAGS Part A*.
ILCR Incremental lifetime excess cancer risk

COCs Identified

USEPA has established a generally acceptable risk range of 1E-04 to 1E-06, and a hazard index threshold of 1.0 (unity). As recommended by SCDHEC, a COC was considered to be any chemical contributing to a cumulative risk level of 1E-06 or greater and/or a cumulative hazard index above 1.0, and whose individual ILCR exceeds 1E-06 or whose hazard quotient exceeds 0.1. For carcinogens, this approach is relatively conservative, since a cumulative risk level of 1E-04 (and individual ILCR of 1E-06) is recommended by USEPA Region IV as the trigger for establishing COCs. The specific COC selection method was used to provide a more comprehensive evaluation of chemicals contributing to carcinogenic risk or non-carcinogenic hazard during the development of remedial goal options. Table 10.11.23 presents the COCs identified for SWMU 12 surface soil and groundwater.

Surface Soils

Hypothetical Site Residents (future land use)

No COCs were identified for this scenario based on the sum ILCR and hazard index.

Future Site Workers (current land use)

No COCs were identified for this scenario based on the sum ILCR and hazard index.

Groundwater

Hypothetical Site Residents (future land use)

Dioxins (2,3,7,8-TCDD equivalents), bis(2-ethylhexyl)phthalate, and arsenic were identified as shallow groundwater COCs based upon their contribution to sum ILCR. Arsenic, cadmium, nickel, and thallium were identified as COCs based upon contribution to pathway hazard indices.

Table 10.11.23
Summary of Risk and Hazard-based COCs for SWMU 12
Charleston Naval Complex
Charleston, South Carolina

Medium	Exposure Pathway		Future Resident Adult Hazard Quotient	Future Resident Child Hazard Quotient	Future Resident LWA ILCR	Future Site Worker Hazard Quotient	Future Site Worker ILCR	Identification of COCs
Surface Soil	Incidental Ingestion	Benzo(a)pyrene Equivalents	ND	ND	5.0E-07	ND	5.6E-08	
		Chromium	0.0092	0.086	ND	0.0033	ND	
	Dermal Contact	Benzo(a)pyrene Equivalents	ND	ND	2.3E-07	ND	9.2E-08	
		Chromium	0.0019	0.0062	ND	0.0013	ND	
Surface Soil Pathway Sum			0.01	0.09	7E-07	0.005	1E-07	
Shallow Groundwater	Ingestion	Arsenic	19	45	4.7E-03	6.8	1.1E-03	1 2 3 4
		Cadmium	0.068	0.16	ND	0.024	ND	1
		Nickel	0.15	0.34	ND	0.052	ND	1
		Thallium	1.1	2.6	ND	0.41	ND	1 3
		bis(2-Ethylhexyl)phthalate (BEHP	0.017	0.040	2.6E-06	0.0061	6.1E-07	2
		Dioxin (TCDD Equivalents)	ND	ND	1.0E-05	ND	2.4E-06	2 4
Shallow Groundwater Pathway Sum			20	48	5E-03	7	1E-03	
Sum of All Pathways			21	48	5E-03	7	1E-03	

Notes:
ND = not determined due to the lack of available information.
ILCR = incremental excess lifetime cancer risk
HI = hazard index
LWA = lifetime-weighted average
1- Chemical is a COC by virtue of projected child resident non-carcinogenic hazard.
2- Chemical is a COC by virtue of projected future resident lifetime ILCR.
3- Chemical is a COC by virtue of projected future site worker non-carcinogenic hazard.
4- Chemical is a COC by virtue of projected future site worker ILCR.

Future Site Workers (current land use)

Arsenic and 2,3,7,8-TCDD equivalents were identified as shallow groundwater COCs based upon their contribution to sum ILCR. Arsenic and thallium were identified as COCs based upon contribution to pathway hazard indices.

Extent of COCs

The extent of the COCs identified in shallow groundwater is discussed briefly below. Arsenic was detected at a concentration exceeding its tap-water RBC (0.045 μg/L) in four groundwater samples. Four samples exceeded the background value (23 μg/L) for arsenic, and also exceeded its MCL (50 μg/L). Cadmium was detected at a concentration exceeding its tap-water RBC (1.8 μg/L) but below its MCL (5 μg/L) in one first-quarter groundwater sample (012002). Nickel was detected at a concentration exceeding its tap-water RBC (73 μg/L) in three groundwater samples; four samples exceeded the background value (13.3 μg/L) for nickel. Thallium was detected at a concentration exceeding its tap-water RBC (0.26 μg/L) and MCL (2 μg/L) in one fourth-quarter groundwater sample (012003). Bis(2-ethylhexyl)phthalate was detected at a concentration exceeding its tap-water RBC (4.8 μg/L) in one fourth-quarter groundwater sample (012003).

Dioxins (2,3,7,8-TCDD equivalents) were reported in two shallow monitoring wells (012001 and 012003), and only one sample (01200101) had a concentration (4.5E-6 μg/L) above the tap-water RBC. The maximum concentration is below the MCL (3E-5 μg/L). Due to the hydrophobic nature of dioxins, they are not expected to migrate from soil-to-groundwater. It is suspected that first-quarter results may reflect the influence of sediment entrained in the monitored zone during well installation.

10.11.6.6 Risk Uncertainty

Characterization of Exposure Setting and Identification of Exposure Pathways

The potential for high bias in exposure assessment is introduced through exposure setting and pathway selection due to the highly conservative assumptions (i.e., future residential use) recommended by USEPA Region IV. The exposure assumptions made in the future site worker scenario are highly conservative and would tend to overestimate exposure. Current site workers are not exposed to site groundwater and are infrequently exposed to surface soils, although direct contact is not inhibited by site features.

Residential use of the site is not be expected or likely, based on current site uses and the nature of surrounding buildings. Current reuse plans call for continued non-residential use of Zone I, with SWMU 12 specifically slated to become open buffer space. If this area were to be used as a residential site, the regrading for development would likely change existing conditions. For example, surface soil would be covered with landscaping soil, a driveway, and/or a house. Consequently, exposure to current surface soil conditions would not be likely under a true future residential scenario. These factors indicate that exposure pathways assessed in this HHRA generally overestimate the risk and hazard posed to current site workers and future site residents.

Shallow groundwater is not currently used at SWMU 12 for potable or industrial purposes. A basewide system provides drinking and process water to buildings throughout Zone I. This system is slated to remain in operation under the current base reuse plan, and, shallow groundwater is not expected to be used under future site use scenarios. Therefore, the scenario associated with shallow groundwater exposure is highly conservative.

Determination of Exposure Point Concentrations

The maximum concentration of benzo(a)pyrene equivalents was applied as the EPC and modified by the corresponding FI/FC factor the UCL was applied as the EPC to estimate soil-related exposures.

For groundwater, the arithmetic mean of the detected concentrations or maximum concentrations was applied as the EPC for each COPC. USEPA Region IV guidance states that the average concentration of each COPC in the most concentrated area of the plume should be used as the EPC. Since a plume cannot be readily defined, this guidance applies only marginally. The spatial variability in groundwater data variability contributes greatly to uncertainty. The 95% UCLs were calculated to provide point estimates to account for this uncertainty, thus providing an upper bound estimate for modeling exposure. For a given COPC, the placement of monitoring wells in uncontaminated areas of the aquifer could cause a low bias on the 95% UCL. As a result, the arithmetic mean of detected concentrations was compared to the 95% UCL, and the greater of the two was selected as the EPC. To address uncertainty resulting from the selection of EPCs and to provide additional perspective, risk/hazard maps may be referenced in the Risk Summary Section.

Uncertainty was introduced into the risk assessment from dioxin SQLs that were relatively high as compared to detected concentrations. To address this uncertainty, the maximum dioxin concentration was used as its EPC. This could result in an overestimate or underestimate of risk associated with dioxin.

Frequency of Detection and Spatial Distribution

Surface Soil

For benzo(a)pyrene equivalents, a hot-spot approach to account for the limited extent of identified impacts, involved applying the maximum concentration of the COPC as the EPC. The hot-spot approach considered the estimated impacted area relative to a standard one-half acre exposure range. BEQs were detected in four of 15 surface soil samples (012SB002, 012SB006, 012SB007, and 012SB014), with a maximum concentration of 0.147 mg/kg. The other three surface soil samples contained less than 0.02 mg/kg BEQs. An FI/FC of 0.3 was derived to account for the limited areal extent of BEQs in surface soil. This factor was conservatively estimated based upon frequency of detection and the approximate size of the impacted area (estimated as 6,000 square feet).

Chromium was detected in all 12 surface soil samples. The maximum chromium detection (39 mg/kg) at location 012SB009 was equal to the RBC.

Groundwater

Arsenic exceeded its tap-water RBC, MCL, and background concentration in four groundwater samples. Cadmium exceeded its tap-water RBC but was below its MCL, in one first-quarter groundwater sample. Nickel exceeded its tap-water RBC in three groundwater samples and exceeded the background concentration in four samples. Thallium exceeded its tap-water RBC and MCL in one fourth-quarter groundwater sample. Bis(2-ethylhexyl)phthalate was detected at a concentration exceeding its tap-water RBC in one fourth-quarter groundwater sample. 2,3,7,8-TCDD equivalents were reported in two groundwater samples, and only one sample (012001) contained TEQs in excess of the tap-water RBC.

Quantification of Risk/Hazard

Many site-specific factors affect the uncertainty of this assessment and cause upward bias in the risk and hazard estimates. Exposure pathway-specific sources of uncertainty are discussed below.

Soil

Of the CPSSs screened and eliminated from formal assessment, none was reported at a concentration close to the corresponding RBC (i.e., within approximately 10% of the RBC). This minimizes the likelihood of potentially significant cumulative risk/hazard with respect to the eliminated CPSSs. Aluminum, arsenic, and manganese exceeded their corresponding RBCs, but they were eliminated from formal assessment based on comparisons to corresponding background concentrations because they did not exceed the corresponding background concentrations.

Although the future land use of SWMU 12 is unknown, both the future worker and residential exposure scenarios were assessed in this HHRA. As previously discussed, it is likely that these scenarios to overestimates risk and/or hazard.

Groundwater

Of the CPSSs screened and eliminated from formal assessment because they did not exceed the RBCs, none was reported at a concentration close to the RBC. This minimizes the likelihood of potentially significant cumulative risk/hazard with respect to the eliminated CPSSs. Manganese exceeded its RBC but was eliminated from formal assessment because it did not exceed its background concentration.

Groundwater is not currently used as a potable water source at SWMU 12 or in the surrounding area. Municipal water is readily available. It is highly unlikely that the site will be developed as a residential area or that a potable-use well would be installed onsite. If residences were constructed onsite and an unfiltered well were installed, the salinity and dissolved solids would likely preclude this aquifer from being an acceptable potable water source.

Background-Related Risk

Soil

Aluminum, arsenic, and manganese were detected in surface soil at concentrations above their respective RBCs. These elements were eliminated from consideration in the risk assessment based on comparison to background values. It is not unusual for naturally occurring or background concentrations of some elements to exceed risk-based concentrations. The following addresses the risk/hazard associated with background concentrations of aluminum, arsenic, and manganese.

The maximum surface soil concentration of aluminum (17,900 mg/kg) for SWMU 12 equates with hazard quotients of 0.3 and 0.01 for the resident child and site worker, respectively. The background value for aluminum (27,400 mg/kg) results in hazard quotients of 0.4 and 0.02 for the resident child and site worker, respectively. The maximum surface soil concentration of arsenic (14.2 mg/kg) equates with ILCRs of 4E-05 and 5E-06 for the residential and site worker scenarios, respectively. The maximum reported concentration of arsenic equates with hazard quotients of 0.7 and 0.03 for the resident child and site worker, respectively. The background value for arsenic (21.6 mg/kg) equates with ILCRs of 5.6E-06 and 8E-06, and hazard quotients of 1 and 0.05 for the residential and site worker scenarios, respectively. The maximum surface soil concentration of manganese (286 mg/kg) equates with hazard quotients of 0.08 and 0.01 for the residential child and site worker, respectively. The background value for manganese (419 mg/kg) results in hazard quotients of 0.06 and 0.01 for the resident child and site worker, respectively.

Groundwater

Manganese was detected in groundwater samples at a concentration exceeding its RBC. This inorganic was eliminated from consideration in the risk assessment based on comparison to its background value. The following addresses the risk/hazard associated with the background concentration of manganese.

The maximum reported concentration of manganese (4,920 μg/L) yielded hazard quotients of 6 and 4 for the residential and site worker scenarios, respectively. Hazard quotients resulting from the background value for manganese (5,430 μg/L) were 7 and 5 for the resident child and site worker, respectively.

10.11.6.7 Risk Summary

The risk and hazard posed by contaminants at SWMU 12 were assessed for the future site worker and future site resident under reasonable maximum exposure assumptions. This HHRA assessed the incidental ingestion and dermal contact pathways for surface soils. The ingestion pathway was evaluated for shallow groundwater, based on four quarters of groundwater monitoring data. Table 10.11.24 presents the risk summary for each pathway/receptor group evaluated.

Soil — Residential Scenario

No residential soil pathway COCs were identified for SWMU 12. Figure 10.11.14 provides the risk map for SWMU 12 soil. As shown, only one sample location was associated with a risk above 1E-06 (012014). Table 10.11.25 provides the point risk and hazard estimates for SWMU 12 soil pathways.

Soil — Industrial Scenario

No industrial soil pathway COCs were identified for SWMU 12.

Groundwater — Residential Scenario

Arsenic, cadmium, nickel, thallium, bis(2-ethylhexyl)phthalate, and dioxin (TCDD equivalents) were identified as groundwater pathway COCs. As shown in Table 10.11.26 and Figure 10.11.15, arsenic was the primary contributor to risk projections for SWMU 12 groundwater. Dioxin and bis(2-ethylhexyl)phthalate were secondary contributors. Risk estimates ranged from 8E-07 (01200301) to 6E-03 (01200204). Arsenic was the primary contributor to hazard estimates, and cadmium, nickel, and thallium were secondary contributors. Figure 10.11.16 shows point hazard estimates for groundwater for the residential scenario. Hazard estimates ranged from 0.04 (01200301) to 54 (01200204).

Table 10.11.24
Summary of Risk and Hazard for SWMU 12
Charleston Naval Complex
Charleston, South Carolina

Medium	Exposure Pathway	HI Resident (Adult)	HI Resident (Child)	ILCR Resident (LWA)	HI (Worker)	ILCR (Worker)
Surface Soil	Incidental Ingestion	0.009	0.09	5E-07	0.003	6E-08
	Dermal Contact	0.002	0.006	2E-07	0.001	9E-08
Shallow Groundwater	Ingestion	20	48	5E-03	7	1E-03
Sum of All Pathways		21	48	5E-03	7	1E-03

Notes:
ND = not determined due to the lack of available information.
ILCR = incremental excess lifetime cancer risk
HI = hazard index
LWA = lifetime-weighted average

Groundwater — Industrial Scenario

Arsenic, thallium, and dioxin (TCDD equivalents) were identified as groundwater pathway COCs. As shown in Table 10.11.27 and Figure 10.11.17, arsenic was the primary contributor to risk projections. Risk estimates ranged from 4E-05 (01200301) to 3E-03 (01200204). Arsenic was the primary contributor to hazard estimates, and cadmium, nickel, and thallium were secondary contributors. Figure 10.11.18 shows point hazard estimates for groundwater for the industrial scenario. Hazard estimates range from 0.013 (01200301) to 17 (01200204).

10.11.6.8 Remedial Goal Options

Soil

No RGOs were computed for the SWMU 12 surface soil, as no COCs were identified.

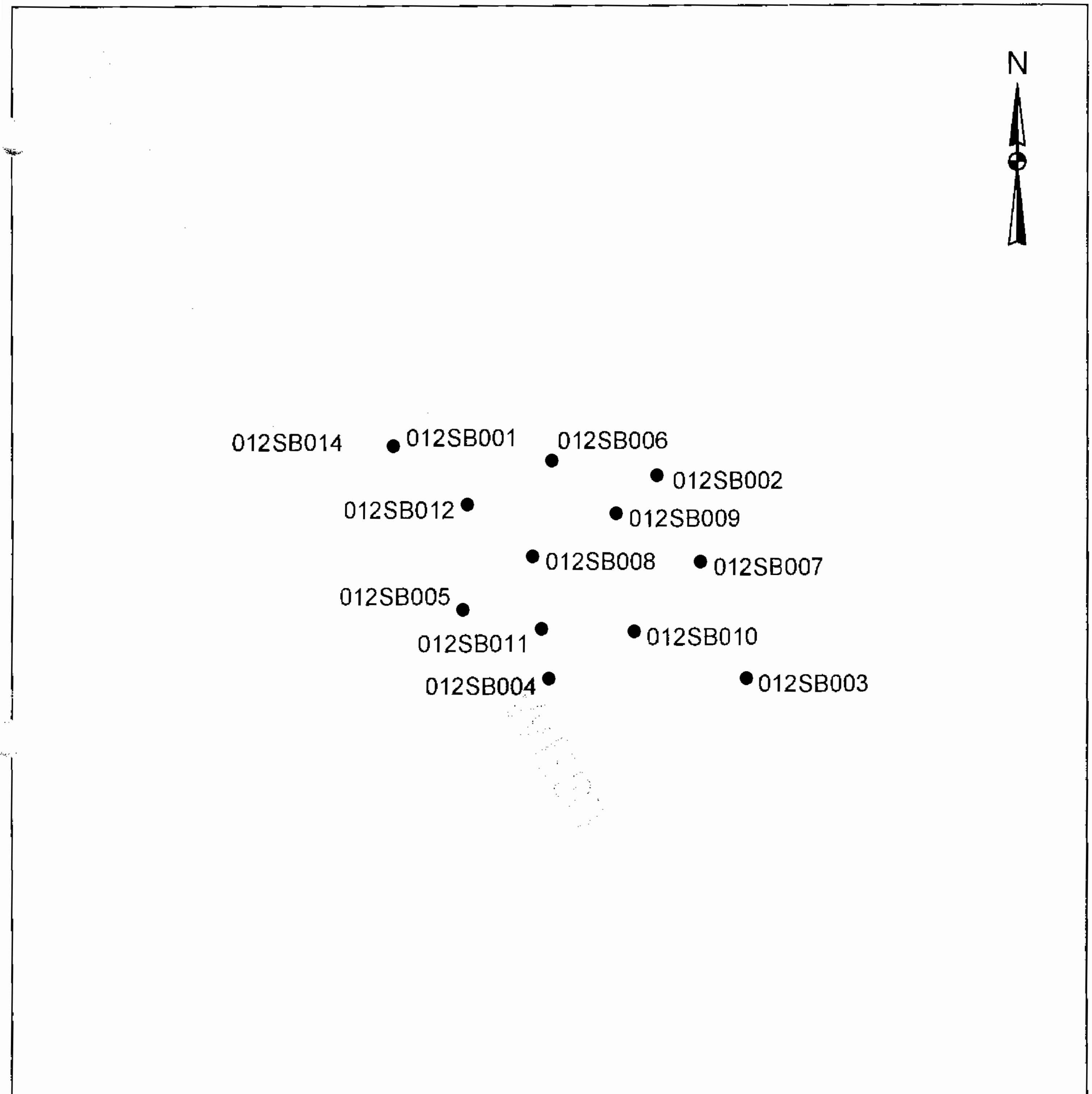
Groundwater

RGOs for carcinogens were based on the lifetime-weighted average future site resident and site worker as presented in Tables 10.11.28 and 10.11.29 respectively for shallow groundwater.

Hazard-based RGOs for the residential scenario were calculated based on the hypothetical child receptor.

10.11.7 Corrective Measures Considerations

Based on the analytical results and human health risk assessment for SWMU 12, COCs requiring further evaluation through the CMS process have been identified for groundwater. The site is in a moderately developed urban setting and risk to human health was evaluated under both future residential and industrial (site worker) scenarios. For these scenarios, the incidental ingestion and dermal contact exposure pathways were evaluated. Hazard was evaluated for noncarcinogenic contaminants through incidental ingestion and dermal contact as well.



LEGEND

- NO COPCs
- < 1E-6
- 1E-6 to 5E-6
- 5E-6 to 1E-5
- 1E-5 to 1E-4
- > 1E-4

60 0 60 120 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.11.14
ZONE I
SWMU 12

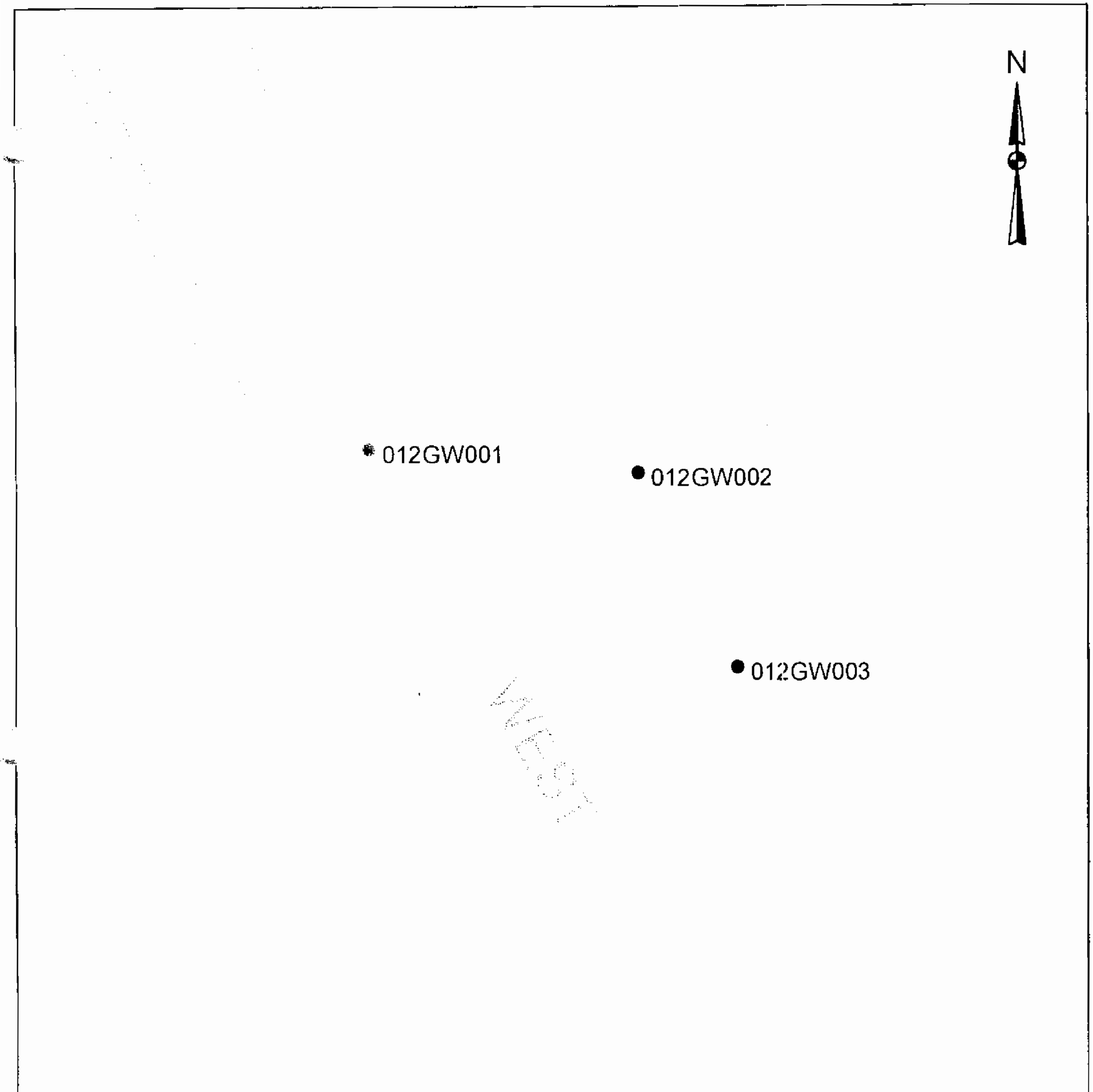
SURFACE SOIL POINT RISK
RESIDENTIAL SCENARIO

Table 10.11.25
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
SWMU 12
Charleston Naval Complex
Charleston, South Carolina

SWMU	Location	Parameter	Concentration	Units	Hazard Index	Risk (E-06)
012	B001	Chromium (Cr)	28.9	mg/kg	0.079	NA
012	B002	Benzo(a)pyrene equivalents	10.1	ug/kg	NA	0.17
012	B002	Chromium (Cr)	33.5	mg/kg	0.092	NA
		Total			0.092	0.17
012	B003	Chromium (Cr)	33.6	mg/kg	0.092	NA
012	B004	Chromium (Cr)	29.6	mg/kg	0.081	NA
012	B005	Chromium (Cr)	25.6	mg/kg	0.070	NA
012	B006	Benzo(a)pyrene equivalents	0.084	ug/kg	NA	NA
012	B006	Chromium (Cr)	37.6	mg/kg	0.103	NA
		Total			0.103	NA
012	B007	Benzo(a)pyrene equivalents	6.065	ug/kg	NA	0.10
012	B007	Chromium (Cr)	23.9	mg/kg	0.066	NA
					0.066	0.10
012	B008	Chromium (Cr)	27.5	mg/kg	0.075	NA
012	B009	Chromium (Cr)	39	mg/kg	0.107	NA
012	B010	Chromium (Cr)	32.8	mg/kg	0.090	NA
012	B010	Chromium (cr6) (Hexavalent)	0.415	mg/kg	0.001	NA
012	B011	Chromium (Cr)	31	mg/kg	0.085	NA
012	B012	Chromium (Cr)	27.8	mg/kg	0.076	NA
012	B013	No COPCs	ND		NA	NA
012	B014	Benzo(a)pyrene equivalents	146.73	ug/kg	NA	2.43
012	B015	No COPCs	ND		NA	NA

Table 10.11.26
Point Estimates of Risk and Hazard - Groundwater Pathways
Residential Scenario
SWMU 12
Charleston Naval Complex
Charleston, South Carolina

SWMU	Location	Round	Parameter		Concentration	Units	Hazard Index	Risk (E-06)
012	W001	01	Dioxin equivalents		4.4974	pg/L	NA	10.03
012	W001	02	No COPCs		ND		NA	NA
012	W001	03	No COPCs		ND		NA	NA
012	W001	04	No COPCs		ND		NA	NA
012	W002	01	Arsenic (As)		177	ug/L	37.717	3948.73
012	W002	01	Cadmium (Cd)		3.1	ug/L	0.396	NA
012	W002	01	Nickel (Ni)		124	ug/L	0.396	NA
				Total			38.510	3948.728
012	W002	02	Arsenic (As)		220	ug/L	46.880	4908.02
012	W002	02	Cadmium (Cd)		1.1	ug/L	0.141	NA
012	W002	02	Nickel (Ni)		88.1	ug/L	0.282	NA
				Total			47.302	4908.024
012	W002	03	Arsenic (As)		188	ug/L	40.061	4194.13
012	W002	03	Nickel (Ni)		167	ug/L	0.534	NA
				Total			40.595	4194.129
012	W002	04	Arsenic (As)		253	ug/L	53.912	5644.23
012	W002	04	Dioxin equivalents		0.0044	pg/L	NA	0.01
012	W002	04	Nickel (Ni)		48.7	ug/L	0.156	NA
				Total			54.067	5644.237
012	W003	01	Cadmium (Cd)		0.3	ug/L	0.038	NA
012	W003	01	Dioxin equivalents		0.366	pg/L	NA	0.82
012	W003	01	Nickel (Ni)		1.5	ug/L	0.005	NA
012	W003	02	No COPCs		ND		NA	NA
012	W003	03	No COPCs		ND		NA	NA
012	W003	04	bis(2-Ethylhexyl)phthalate (BEH		20	ug/L	0.064	4.16
012	W003	04	Thallium (Tl)		4.3	ug/L	3.436	NA
				Total			3.500	4.16



LEGEND

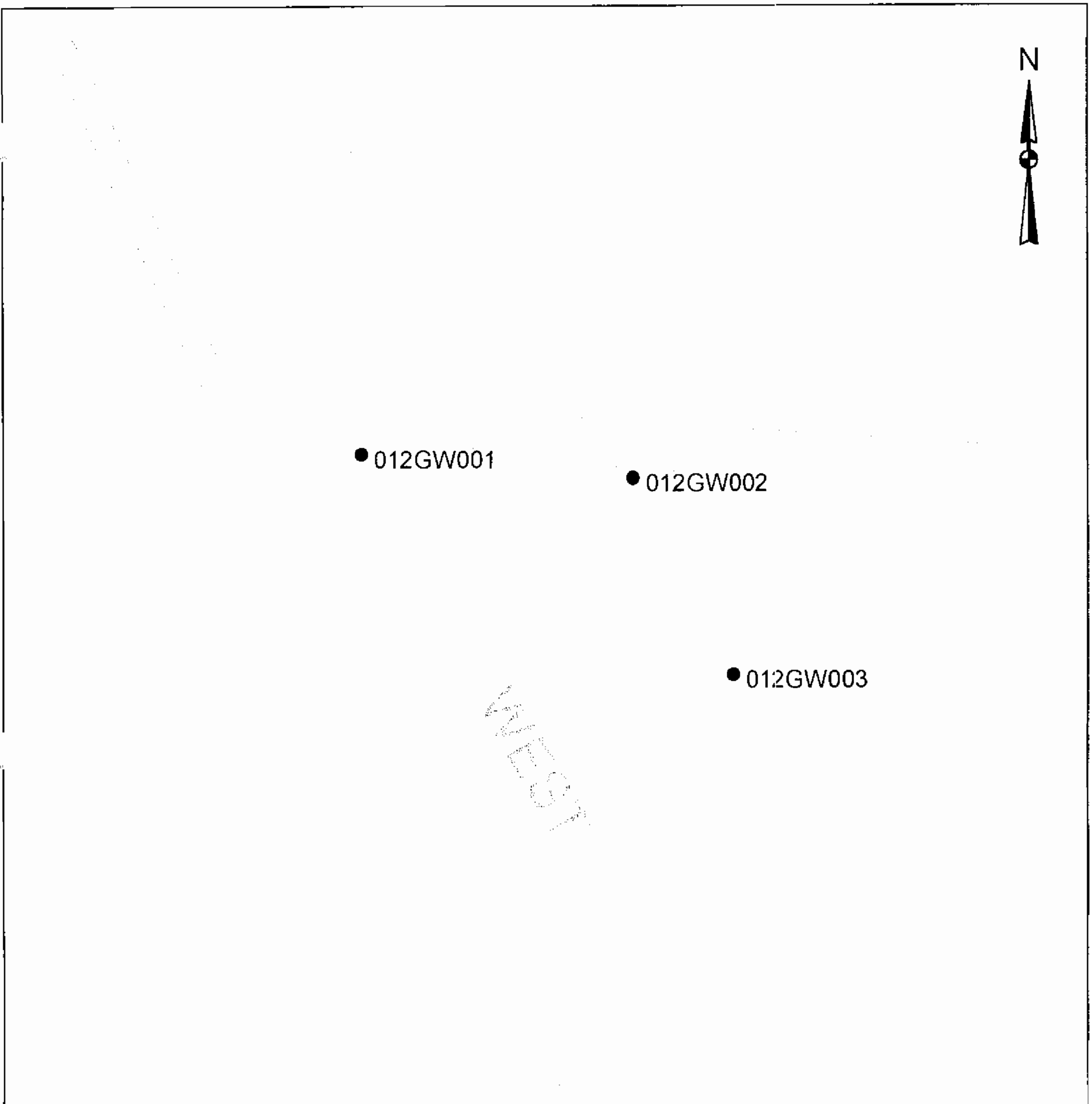
- NO COPCs
- < 1E-6
- 1E-6 to 5E-6
- 5E-6 to 1E-5
- 1E-5 to 1E-4
- > 1E-4

60 0 60 120 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.11.15
ZONE I
SWMU 12

GROUNDWATER POINT RISK
RESIDENTIAL SCENARIO



LEGEND

- NO COPCs
- 0 to 0.1
- 0.1 to 0.5
- 0.5 to 1.0
- 1.0 to 3.0
- > 3.0

50 0 50 100 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.11.16
ZONE I
SWMU 12

GROUNDWATER HAZARD INDEX
RESIDENTIAL SCENARIO

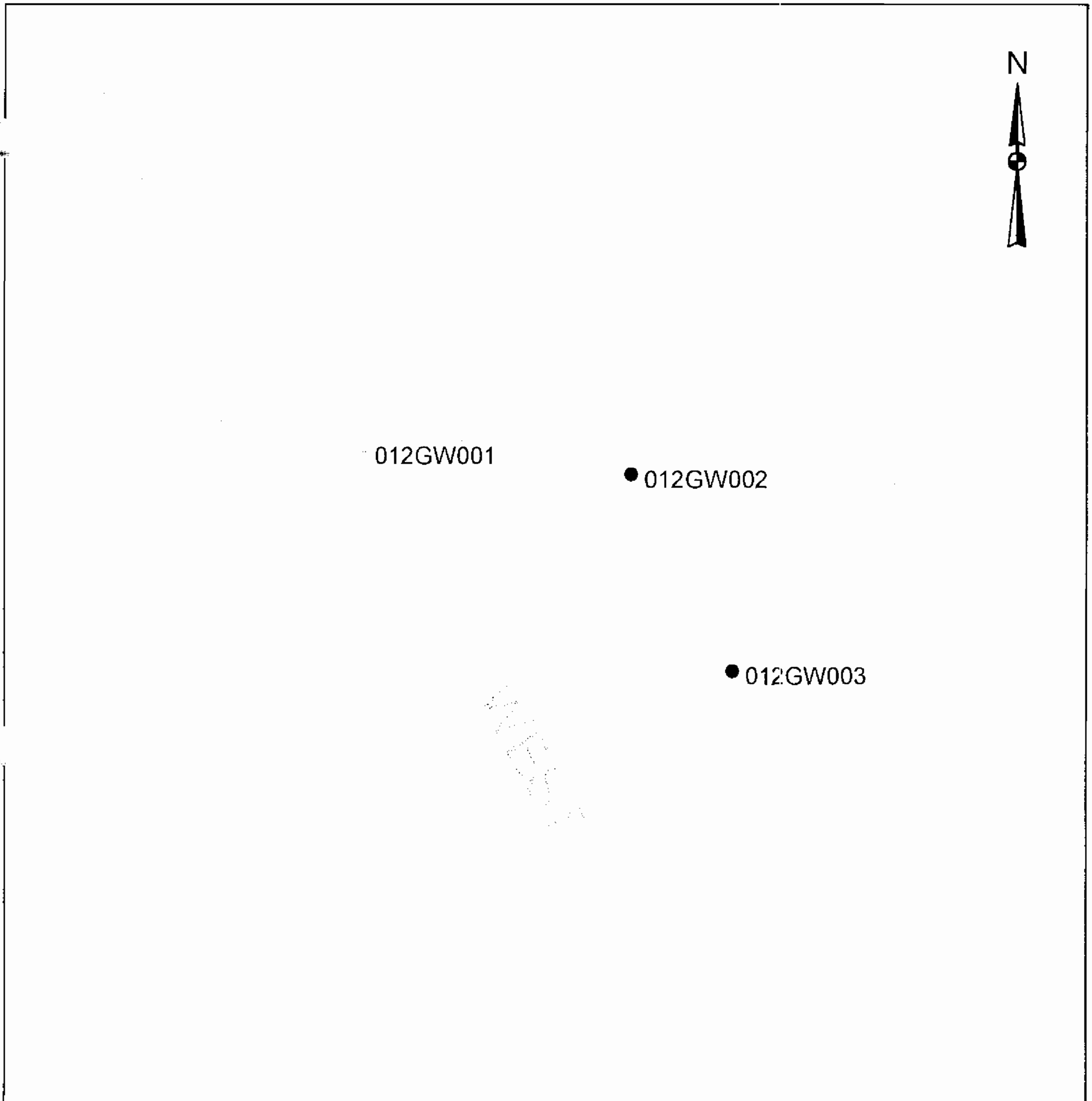
Table 10.11.27
Point Estimates of Risk and Hazard - Groundwater Pathways
Site Worker Scenario
SWMU 12
Charleston Naval Complex
Charleston, South Carolina

SWMU	Location	Round	Parameter	Concentration	Units	Hazard Index	Risk (E-06)
012	W001	01	Dioxin equivalents	4.4974	ug/L	NA	4.71
012	W001	02	No COPCs	ND		NA	NA
012	W001	03	No COPCs	ND		NA	NA
012	W001	04	No COPCs	ND		NA	NA
012	W002	01	Arsenic (As)	177	ug/L	11.546	1855.61
012	W002	01	Cadmium (Cd)	3.1	ug/L	0.121	NA
012	W002	01	Nickel (Ni)	124	ug/L	0.121	NA
			Total			11.789	1855.61
012	W002	02	Arsenic (As)	220	ug/L	14.351	2306.40
012	W002	02	Cadmium (Cd)	1.1	ug/L	0.043	NA
012	W002	02	Nickel (Ni)	88.1	ug/L	0.086	NA
			Total			14.480	2306.40
012	W002	03	Arsenic (As)	188	ug/L	12.264	1970.93
012	W002	03	Nickel (Ni)	167	ug/L	0.163	NA
			Total			12.427	1970.93
012	W002	04	Arsenic (As)	253	ug/L	16.504	2652.36
012	W002	04	Dioxin equivalents	0.0044	ug/L	NA	NA
012	W002	04	Nickel (Ni)	48.7	ug/L	0.048	NA
			Total			16.551	2652.36
012	W003	01	Cadmium (Cd)	0.3	ug/L	0.012	NA
012	W003	01	Dioxin equivalents	0.366	ug/L	NA	0.38
012	W003	01	Nickel (Ni)	1.5	ug/L	0.001	NA
			Total			0.013	0.38
012	W003	02	No COPCs	ND		NA	NA
012	W003	03	No COPCs	ND		NA	NA
012	W003	04	bis(2-Ethylhexyl)phthalate (BEHP)	20	ug/L	0.020	1.96
012	W003	04	Thallium (Tl)	4.3	ug/L	1.052	NA
			Total			1.071	1.96

As recommended by SCDHEC, a COC is considered to be any chemical contributing to a cumulative risk level of 1E-06 or greater and/or a cumulative hazard index above 1.0, and whose individual risk exceeds 1E-06 or whose hazard quotient exceeds 0.1.

No soil pathway COCs were identified for SWMU 12. Arsenic, bis(2-ethylhexyl)phthalate, cadmium, nickel, thallium, and TEQs were identified as groundwater COCs. Table 10.11.30 presents cumulative and COC-specific exposure risks and hazard quotients.

Risk-based remedial goals for shallow groundwater are presented in Tables 10.11.28 and 10.11.29. Potential corrective measures for soil are presented in Table 10.11.31.



LEGEND

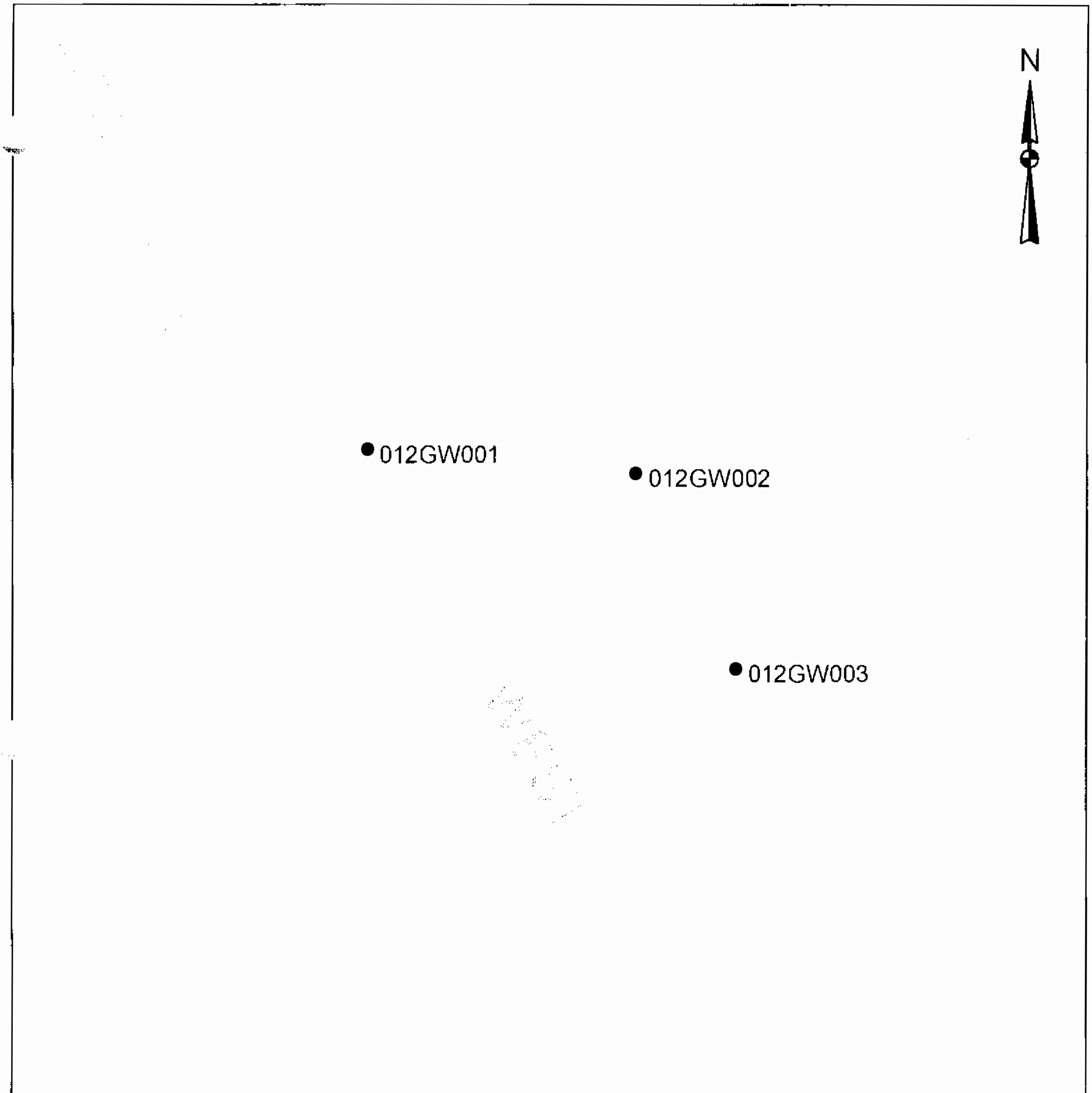
- NO COPCs
- < 1E-6
- 1E-6 to 5E-6
- 5E-6 to 1E-5
- 1E-5 to 1E-4
- > 1E-4

60 0 60 120 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.11.17
ZONE I
SWMU 12

GROUNDWATER POINT RISK
INDUSTRIAL SCENARIO



LEGEND

- NO COPCs
- 0 to 0.1
- 0.1 to 0.5
- 0.5 to 1.0
- 1.0 to 3.0
- > 3.0

60 0 60 120 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.11.18
ZONE I
SWMU 12

GROUNDWATER HAZARD INDEX
INDUSTRIAL SCENARIO

Table 10.11.28
Residential-Based Remedial Goal Options Shallow Groundwater
SWMU 12
Charleston Naval Complex
Charleston, South Carolina

Chemical	Oral SF $(mg/kg\text{-}day)^{-1}$	Oral RfD (mg/kg-day)	EPC mg/l	Hazard-Based Remedial Goal Options **0.1** mg/l	**1.0** mg/l	**3** mg/l	Risk-Based Remedial Goal Options **1E-06** mg/l	**1E-05** mg/l	**1E-04** mg/l	MCL mg/l	Background Concentration mg/l
Arsenic	1.5	0.0003	0.21	0.00047	0.0047	0.014	0.000044	0.00044	0.0044	0.05	0.023
Cadmium	NA	0.0005	0.0012	0.00078	0.0078	0.023	ND	ND	ND	0.005	NA
Nickel	NA	0.02	0.11	0.031	0.31	0.94	ND	ND	ND	0.1	0.0133
Thallium	NA	7E-05	0.0029	0.00011	0.0011	0.003	ND	ND	ND	0.002	0.002
bis(2-Ethylhexyl)phthalate (BEHP)	0.014	0.02	0.013	0.031	0.31	0.94	0.0047	0.047	0.47	NA	NA
Dioxin (TCDD Equivalents)	150000	NA	4.5E-09	ND	ND	ND	4.4E-10	4.4E-09	4.4E-08	3E-08	NA

Notes:
EPC Exposure point concentration
NA Not applicable
ND Not determined
- Remedial goal options were based on the resident lifetime-weighted average for carcinogens and the child resident for noncarcinogens
The nickel MCL is being remanded by the USEPA Office of Water

Table 10.11.29
Worker-Based Remedial Goal Options Shallow Groundwater
SWMU 12
Charleston Naval Complex
Charleston, South Carolina

Chemical	Oral SF (mg/kg-day)$^{-1}$	Oral RfD (mg/kg-day)	EPC mg/l	Hazard-Based Remedial Goal Options 0.1 mg/l	1.0 mg/l	3 mg/l	Risk-Based Remedial Goal Options 1E-06 mg/l	1E-05 mg/l	1E-04 mg/l	MCL mg/l	Background Concentration mg/l
Arsenic	1.5	0.0003	0.21	0.0031	0.031	0.31	0.00019	0.0019	0.019	0.05	0.023
Thallium	NA	7E-05	0.0029	0.0007	0.007	0.07	ND	ND	ND	0.002	0.002
Dioxin (TCDD Equivalents)	150000	NA	4.5E-09	ND	ND	ND	1.9E-09	1.9E-08	1.9E-07	3E-08	NA

Notes:
EPC Exposure point concentration
NA Not applicable
ND Not determined

Table 10.11.30
SWMU 12
Cumulative and Chemical-Specific Exposure Risks and Hazard

Chemical	Risk: Industrial	Risk: Residential	Hazard: Industrial	Hazard: Residential
Groundwater				
Arsenic	1.1E-3	4.7E-3	6.8	45
Bis(2-ethylhexyl)phthalate	6.1E-7	2.6E-6	0.0061	0.040
Cadmium	ND	ND	0.024	0.16
Nickel	ND	ND	0.052	0.34
Thallium	ND	ND	0.41	2.6
TEQs	2.4E-6	1.0E-5	ND	ND
Cumulative	1.1E-3	4.7E-3	7.3	48

Note:
ND = Not detected

Table 10.11.31
SWMU 12
Potential Corrective Measures

Medium	Compounds	Potential Corrective Measures
Groundwater	Arsenic, Bis(2-ethylhexyl)phthalate, Cadmium, Nickel, Thallium, TEQs	a) No action b) Monitoring c) Ex-situ physical/chemical treatment and discharge to POTW d) Ex-situ physical/chemical treatment and discharge through NPDES permitting

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10.12 SWMU 177/RTC

The SWMU 177/RTC was not addressed in the *Final Zone I RFI Work Plan* (E/A&H, February 1995). This site was determined by USEPA Region IV to warrant limited investigation in conjunction with current construction activities. SWMU 177/RTC consisted of two adjacent buildings, both designated as Building RTC-4. The original RTC-4 was a 24 x 60 foot metal structure used to house heavy equipment including backhoes and trackhoes. The designation RTC-4 was given to a newer building constructed next to the former RTC-4. The newer RTC-4 was used to store lawn mowers and other lawn maintenance equipment. This unit was designated as a SWMU due to oil spillage associated with operations at the two buildings. Visual inspections during rhe RFA identified several areas of stained soil and concrete in and around the two buildings. These buildings were both less than 50 feet from the Cooper River.

This area was included in a lease agreement between the Navy and the National Oceanographic and Atmospheric Administration (NOAA) in the spring of 1995. Since taking over this area, NOAA has removed both buildings and has installed a diesel fuel AST and three generators at the site.

Materials of concern identified include VOCs, petroleum hydrocarbons, and heavy metals. Potential receptors include current or future site workers who may be involved in invasive activities that might bring them in direct contact with subsurface contaminants. The ecology of the Cooper River is also a potential receptor.

The initial samples were collected to facilitate the property transfer and expansion. Subsequent sampling rounds were conducted to confirm the presence of any contamination from onsite activities. Soil and groundwater were sampled in accordance with Section 3 of this report.

10.12.1 Soil Sampling and Analysis

Four rounds of soil sampling were performed at SWMU 177/RTC. The locations are shown on Figure 10.12.1. All first-round and second-round samples were analyzed at DQO Level III for VOCs, SVOCs, pesticides/PCBs, cyanide, metals. One sample selected as a duplicate was analyzed at DQO Level IV for Appendix IX analytical parameters. Two first-round soil borings (upper and lower-intervals) were analyzed for dioxins. Seven second-round upper-interval borings and six lower-interval borings were analyzed for dioxins. Third and fourth-round samples were anlayzed for VOCs and SVOCs. Table 10.12.1 summarizes the four rounds of soil sampling.

Table 10.12.1
SWMU 177/RTC
Soil Sampling Summary

Sampling Round	Sampling Date	Samples Collected	Sample Analyses
1	05/26/95	Upper - 10 (10)	Standard Suite
		Duplicate - 2	Standard Suite, Dioxins
2	06/07/96	Upper - 7	Standard Suite, DRO, GRO, Dioxins
		Lower - 6	Standard Suite, DRO, GRO, Dioxins
3	04/03/98	Upper - 8	VOCs, SVOCs
		Lower - 6	VOCs, SVOCs
4	06/17/98	Upper - 4	VOCs, SVOCs
		Lower - 4	VOCs, SVOCs

Notes:
( ) = Parentheses indicate the number of samples proposed.
Standard Suite = VOCs, SVOCs, metals, cyanide, pesticides, and PCBs were analyzed at DQO Level III.

Grid-based soil boring (GDISB016) was advanced in the area of SWMU 177/RTC as shown on Figure 10.12.1. Upper-interval samples from this boring were analyzed for the standard suite of parameters. Results of these analyses are presented in the nature and extent discussion of SWMU 177/RTC and presented in Appendix D.

10.12.2 Nature and Extent of Organic and Inorganics in Soil

Organic compound analytical data for soil are summarized in Table 10.12.2. Inorganic analytical data for soil are summarized in Table 10.12.3. Table 10.12.4 summarizes all analytes detected in soil at SWMU 177/RTC. Appendix D contains the complete analytical data report for all samples collected in Zone I.

Table 10.12.2
SWMU 177/RTC Soil
Organic Compound Analytical Results for Soil (μg/kg)

Parameters	Sampling Interval	Detection Frequency	Detection Range	Mean	RBC (upper) SSL (lower)	Number of Samples Exceeding RBC or SSL
Acetone	Upper	7/29	8.00 - 160	62.8	780000	0
	Lower	6/16	22.0 - 130	50.8	8000	0
Benzene	Upper	1/29	0.84	0.84	22000	0
	Lower	0/16	ND	ND	15	0
2-Butanone (MEK)	Upper	1/29	3.00	3.00	4,700,000	0
	Lower	6/16	3.00 - 27.0	10.0	3900	0
Carbon Disulfide	Upper	0/29	ND	ND	780000	0
	Lower	3/16	2.0 - 4.0	3.0	16000	0
1,1-Dichloroethene	Upper	1/29	2.00	2.00	1100	0
	Lower	0/16	ND	ND	30	0
1,2-Dichloroethene (total)	Upper	1/29	6.00	6.00	70000	0
	Lower	1/16	6.70	6.70	200	0
Ethylbenzene	Upper	5/29	0.64 - 1.80	1.15	780000	0
	Lower	3/16	0.88 - 1.10	0.953	6500	0
Methylene Chloride	Upper	2/29	7.0 - 12.0	9.5	85000	0
	Lower	2/16	2.7 - 15.0	8.85	10	1
4-Methyl-2-Pentanone (MIBK)	Upper	1/29	6.0	6.0	630,000	0
	Lower	0/19	ND	ND	6,700	0
1,1,2,2-Tetrachloroethane	Upper	1/29	2.00	2.00	3200	0
	Lower	0/16	ND	ND	1.5	0
Toluene	Upper	3/29	0.77 - 1.90	1.16	1600000	0
	Lower	2/16	0.76 - 0.77	0.765	6000	0
Trichloroethene (TCE)	Upper	4/29	2.0 - 3.0	2.5	58000	0
	Lower	0/16	ND	ND	30	0
Xylene	Upper	5/29	4.3 - 7.9	5.82	16000000	0
	Lower	5/16	2.4 - 4.7	3.66	70000	0

Table 10.12.2
SWMU 177/RTC Soil
Organic Compound Analytical Results for Soil (μg/kg)

Parameters	Sampling Interval	Detection Frequency	Detection Range	Mean	RBC (upper) SSL (lower)	Number of Samples Exceeding RBC or SSL
Semivolatile Organic Compounds						
Acenaphthene	Upper	2/29	57.0 - 98.0	77.5	470000	0
	Lower	0/16	ND	ND	290000	0
Acenaphthylene	Upper	1/29	150	150	310000	0
	Lower	0/16	ND	ND	96000	0
Anthracene	Upper	2/29	37.0 - 140	88.5	2300000	0
	Lower	1/16	170	170	5900000	0
Benzoic Acid	Upper	2/29	220 - 1200	710	31000000	0
	Lower	3/16	48.0 - 240	176	200000	0
Benzo(g,h,i)perylene	Upper	3/29	53.0 - 650	252	310,000	0
	Lower	1/16	1300	1300	1.2E+8	0
BEQ	Upper	7/29	2.42 - 1274	235	87	3
	Lower	1/16	2878	2878	1600	1
Benzo(a)anthracene	Upper	4/29	43.0 - 910	291	870	1
	Lower	1/16	860	860	800	1
Benzo(a)pyrene	Upper	5/29	15.0 - 1000	257	87	2
	Lower	1/16	2000	2000	4000	0
Benzo(b)fluoranthene	Upper	7/29	24.0 - 1000	210	870	1
	Lower	0/16	ND	ND	2500	0
Benzo(k)fluoranthene	Upper	4/29	48.0 - 1100	357	8700	0
	Lower	1/16	3100	3100	25000	0
Chrysene	Upper	6/29	17.0 - 1000	222	87000	0
	Lower	1/16	1000	1000	80000	0
Dibenz(a,h)anthracene	Upper	0/29	ND	ND	87	0
	Lower	1/16	600	600	800	0
Indeno(1,2,3-cd)pyrene	Upper	3/29	52.0 - 710	273	870	0
	Lower	1/16	1600	1600	7000	0
bis (2-Ethylhexyl) phthalate	Upper	8/29	45.0 - 770	208	46000	0
	Lower	2/16	87 - 87	87	1800000	0
Butylbenzylphthalate	Upper	2/29	33.0 - 79.0	56.0	1600000	0
	Lower	0/16	ND	ND	930000	0
Di-n-butylphthalate	Upper	8/29	39.0 - 97.0	68.4	780000	0
	Lower	0/16	ND	ND	2300000	0
Diethylphthalate	Upper	0/29	ND	ND	6300000	0
	Lower	1/16	48.0	48.0	230000	0
Fluoranthene	Upper	7/29	26.0 - 1400	287	310000	0
	Lower	1/16	700	700	2100000	0

Table 10.12.2
SWMU 177/RTC Soil
Organic Compound Analytical Results for Soil (μg/kg)

Parameters	Sampling Interval	Detection Frequency	Detection Range	Mean	RBC (upper) SSL (lower)	Number of Samples Exceeding RBC or SSL
Phenanthrene	Upper	3/29	80.0 - 790	343	23000	0
	Lower	1/16	110	110	660000	0
Pyrene	Upper	7/29	18.0 - 1700	310	230000	0
	Lower	1/16	740	740	2100000	0
Pesticides/PCBs						
Aroclor-1260	Upper	2/17	33.0 - 190	111	320	0
	Lower	0/6	ND	ND	1000	0
delta-BHC	Upper	1/17	0.9	0.9	350	0
	Lower	0/6	ND	ND	1.8	0
alpha-Chlordane	Upper	1/17	4.25	4.25	1800	0
	Lower	0/6	ND	ND	5000	0
gamma-Chlordane	Upper	1/17	6.95	6.95	1800	0
	Lower	1/6	4.10	4.10	5000	0
4,4'-DDD	Upper	7/17	0.22 - 6.80	3.30	2700	0
	Lower	0/6	ND	ND	8,000	0
4,4'-DDE	Upper	10/17	3.80 - 75.5	32.0	1900	0
	Lower	2/6	12.0 - 39.0	25.5	27000	0
4,4'-DDT	Upper	11/17	0.085 - 38.0	12.3	1900	0
	Lower	2/6	6.00 - 37.0	21.5	16000	0
Chlordane	Upper	4/17	40.0 - 680	227	1800	0
	Lower	0/6	ND	ND	4000	0
Dieldrin	Upper	1/17	3.7	3.7	40	0
	Lower	0/6	ND	ND	2.0	0
Endosulfan II	Upper	1/17	0.045	0.045	47000	0
	Lower	0/6	ND	ND	9000	0
Endrin	Upper	3/17	2.2 - 5.1	3.37	2300	0
	Lower	0/6	ND	ND	500	0
Endrin aldehyde	Upper	1/17	5.2	5.2	2300	0
	Lower	0/6	ND	ND	340	0
Heptachlor Epoxide	Upper	3/17	0.57 - 3.05	2.17	70	0
	Lower	0/6	ND	ND	330	0
Methoxychlor	Upper	1/17	2.00	2.00	39000	0
	Lower	1/6	71.0	71.0	80000	0
Dioxins, Furans, and Organotins						
TEQ	Upper	9/9	2.86E-5 - 1.67E-3	4.30E-4	4.3E-3	0
	Lower	6/6	4.34E-6 - 1.20E-4	4.74E-5	1.60	0
1234678-HpCDD	Upper	9/9	1.32E-3 - 4.65E-2	1.45E-2	4.3E-1	0
	Lower	5/6	1.39E-3 - 4.32E-2	2.35E-3	108	0

Table 10.12.2
SWMU 177/RTC Soil
Organic Compound Analytical Results for Soil (μg/kg)

Parameters	Sampling Interval	Detection Frequency	Detection Range	Mean	RBC (upper) SSL (lower)	Number of Samples Exceeding RBC or SSL
1234678-HpCDF	Upper	6/9	1.12E-3 - 3.07E-2	9.53E-3	4.3E-1	0
	Lower	4/6	3.38E-4 - 1.74E-3	9.62E-4	54	0
123478-HxCDD	Upper	1/9	6.15E-4	6.15E-4	4.3E-2	0
	Lower	0/6	ND	ND	4.1	0
123678-HxCDD	Upper	1/9	2.21E-3	2.21E-3	4.3E-2	0
	Lower	0/6	ND	ND	4.1	0
123678-HxCDF	Upper	1/9	7.85E-4	7.85E-4	4.3E-2	0
	Lower	0/6	ND	ND	216	0
123789-HxCDD	Upper	1/9	1.58E-3	1.58E-3	4.3E-2	0
	Lower	0/6	ND	ND	4.1	0
234678-HxCDF	Upper	1/9	1.0E-3	1.0E-3	4.3E-2	0
	Lower	1/6	3.41E-4	3.41E-4	216	0
OCDD	Upper	9/9	1.21E-2 - 5.29E-1	1.47E-1	4.3	0
	Lower	6/6	4.34E-3 - 2.49E-2	1.55E-2	1080	0
OCDF	Upper	7/9	4.70E-4 - 2.04E-2	6.38E-3	4.3	0
	Lower	3/6	2.25E-4 - 6.73E-4	4.54E-4	540	0
TPH-DRO						
Diesel	Upper	1/7	36900	36900	NA	NA
	Lower	0/6	ND	ND	NA	NA
TPH-GRO						
Gasoline	Upper	1/5	21.2	21.2	NA	NA
	Lower	0/5	ND	ND	NA	NA

Notes:
NA = Not Applicable/Not Available/Not Analyzed
ND = Not Detected/Not Determined
NL = Not listed
μg/kg = Micrograms per kilogram
See Table 5.5 for organic compound screening concentrations and their sources.

Table 10.12.3
SWMU177/RTC
Inorganic Analytical Results for Soil (mg/kg)

Parameters	Sample Interval	Detection Frequency	Detection Range	Mean	Background Concentration	RBC (upper) SSL (lower)	Number of Samples Exceeding RBC and Background (upper) or SSL and Background (lower)
Aluminum (Al)	Upper	17/17	990 - 5930	2870	27400	7800	0
	Lower	6/6	1170 - 4280	2905	18900	560000	0
Arsenic (As)	Upper	16/17	0.61 - 5.20	2.50	21.3	0.43	0
	Lower	6/6	2.20 - 4.30	3.10	6.45	15	0
Barium (Ba)	Upper	17/17	5.3 - 20.6	10.4	54.2	550	0
	Lower	6/6	4.00 - 10.9	7.37	36	820	0
Beryllium (Be)	Upper	7/17	0.16 - 0.34	0.25	0.95	16	0
	Lower	6/6	0.25 - 0.43	0.33	0.67	32	0
Cadmium (Cd)	Upper	5/17	0.26 - 0.44	0.36	0.61	7.8	0
	Lower	1/6	0.13	0.13	0.54	4.0	0
Chromium (Cr)	Upper	17/17	3.30 - 12.3	6.95	34.5	39	0
	Lower	6/6	5.1 - 13.5	8.3	51.3	19	0
Cobalt (Co)	Upper	17/17	0.49 - 3.00	1.19	5.8	470	0
	Lower	6/6	0.96 - 1.8	1.31	3.48	990	0
Copper (Cu)	Upper	17/17	1.1 - 112	9.80	240	310	0
	Lower	6/6	0.83 - 3.6	2.12	11.5	5600	0
Cyanide (CN)	Upper	2/17	0.22 - 0.24	0.23	ND	160	0
	Lower	0/6	ND	ND	ND	20	0
Lead (Pb)	Upper	17/17	2.5 - 83.6	13.9	203	400	0
	Lower	6/6	1.7 - 13.1	5.20	12.3	400	0
Manganese (Mn)	Upper	17/17	10.2 - 118	40.7	419	160	0
	Lower	6/6	25.8 - 56.0	38.9	118	480	0
Mercury (Hg)	Upper	1/17	0.26	0.26	0.47	2.3	0
	Lower	1/6	0.21	0.21	ND	1.0	0

Table 10.12.3
SWMU177/RTC
Inorganic Analytical Results for Soil (mg/kg)

Parameters	Sample Interval	Detection Frequency	Detection Range	Mean	Background Concentration	RBC (upper) SSL (lower)	Number of Samples Exceeding RBC and Background (upper) or SSL and Background (lower)
Nickel (Ni)	Upper	17/17	0.99 - 7.60	2.51	23.9	160	0
	Lower	6/6	1.8 - 4.0	2.53	15.7	65	0
Selenium (Se)	Upper	3/17	0.56 - 0.78	0.65	1.49	39	0
	Lower	0/6	ND	ND	1.77	2.6	0
Tin (Sn)	Upper	1/17	2.4	2.4	7.5	4700	0
	Lower	4/6	2.5 - 3.0	2.75	ND	5500	0
Vanadium (V)	Upper	17/17	3.1 - 13.7	7.61	113	55	0
	Lower	6/6	4.3 - 10.7	7.48	38.1	3000	0
Zinc (Zn)	Upper	17/17	5.10 - 137	28.2	206	2300	0
	Lower	6/6	6.80 - 43.7	21.1	36.2	6200	0

Note:
ND = Not Detected

Table 10.12.4
SWMU 177/RTC
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Volatile Organic Compounds (μg/kg)							
Acetone	177SB001	18	780000	NA	NT	8000	NA
	177SB003	ND			28		
	177SB005	160			ND		
	177SB009	ND			37		
	177SB012	ND			40.5		
	177SB013	ND			47		
	177SB014	ND			130		
	177SB015	ND			22		
	RTCSB002	14			NT		
	RTCSB004	98			NT		
	RTCSB007	130			NT		
	RTCSB008	12			NT		
	RTCSB009	8			NT		
Benzene	177SB010	0.84	22000	NA	NT	15	NA

Table 10.12.4
SWMU 177/RTC
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
2-Butanone (MEK)	177SB005	ND	4700000	NA	6	3900	NA
	177SB009	ND			7.1		
	177SB012	ND			9.4		
	177SB013	ND			7.5		
	177SB014	ND			27		
	177SB017	3			ND		
	177SB019	ND			3		
Carbon disulfide	177SB005	ND	780000	NA	2	16000	NA
	177SB018	ND			3		
	177SB019	ND			4		
1,1-Dichloroethene	177SB005	2	1100	NA	ND	30	NA
1,2-Dichloroethene (total)	177SB002	6	70000	NA	ND	200	NA
	177SB012	ND			6.7		
Ethylbenzene	177SB009	ND	780000	NA	0.88	6500	NA
	177SB010	1.8			NT		
	177SB011	0.81			NT		
	177SB012	1.2			0.88		
	177SB013	1.3			1.1		
	177SB014	0.64			ND		

Table 10.12.4
SWMU 177/RTC
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Methylene chloride	177SB001	12	85000	NA	NT	10	NA
	177SB003	7			15		
	177SB012	ND			2.7		
4-Methyl-2-Pentanone (MIBK)	177SB017	6	630000	NA	ND	6700	NA
1,1,2,2-Tetrachloroethane	177SB017	2	3200	NA	ND	1.5	NA
Toluene	177SB009	ND	1600000	NA	0.76	6000	NA
	177SB010	1.9			NT		
	177SB012	0.8			ND		
	177SB013	0.77			ND		
	177SB014	ND			0.77		
Trichloroethene (TCE)	177SB005	3	58000	NA	ND	30	NA
	177SB006	3			ND		
	177SB007	2			ND		
	177SB017	2			ND		
Xylene (total)	177SB009	ND	16000000	NA	4.3	70000	NA
	177SB010	7.9			NT		
	177SB012	5.5			3.7		
	177SB013	6.8			4.7		
	177SB014	4.3			3.2		
	177SB015	4.6			2.4		

Table 10.12.4
SWMU 177/RTC
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Semivolatile Organic Compounds (μg/kg)							
Acenaphthene	177SB010	57	470000	NA	NT	290000	NA
	RTCSB003	98			NT		
Acenaphthylene	177SB007	ND	310000	NA	150	96000	NA
Anthracene	177SB007	ND	2300000	NA	170	5900000	NA
	177SB010	140			NT		
	177SB012	37			ND		
Benzoic acid	177SB002	ND	31000000	NA	48	200000	NA
	177SB016	ND			240		
	177SB018	220			240		
	177SB019	1200			ND		
Benzo(g,h,i)perylene	177SB007	ND	310000	NA	1300	1.2e+08	NA
	177SB010	650			NT		
	177SB018	54			ND		
	RTCSB010	53			NT		
Benzo(a)pyrene Equivalents (BEQs)	177SB007	ND	87	NA	**2878**	1600	NA
	177SB010	**1274**			NT		
	177SB012	**98.5**			ND		
	177SB013	17.6			ND		
	177SB016	4.1			ND		
	177SB017	2.4			ND		
	177SB018	64.9			ND		
	RTCSB010	**182**			NT		

Table 10.12.4
SWMU 177/RTC
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Benzo(a)anthracene	177SB007	ND	870	NA	860	800	NA
	177SB010	910			NT		
	177SB012	80			ND		
	177SB018	43			ND		
	RTCSB010	130			NT		
Benzo(a)pyrene	177SB007	ND	87	NA	2000	4000	NA
	177SB010	1000			NT		
	177SB012	75			ND		
	177SB013	15			ND		
	177SB018	53			ND		
	RTCSB010	140			NT		
Benzo(b)fluoranthene	177SB010	1000	870	NA	NT	2500	NA
	177SB012	97			ND		
	177SB013	26			ND		
	177SB014	24			ND		
	177SB016	41			ND		
	177SB018	71			ND		
	RTCSB010	210			NT		

Table 10.12.4
SWMU 177/RTC
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Benzo(k)fluoranthene	177SB007	ND	8700	NA	3100	25000	NA
	177SB010	1100			NT		
	177SB012	50			ND		
	177SB018	48			ND		
	RTCSB010	230			NT		
Chrysene	177SB007	ND	87000	NA	1000	80000	NA
	177SB010	1000			NT		
	177SB012	88			ND		
	177SB013	19			ND		
	177SB014	17			ND		
	177SB018	50			ND		
	RTCSB010	160			NT		
Dibenz(a,h)anthracene	177SB007	ND	87	NA	600	800	NA
Indeno(1,2,3-cd)pyrene	177SB007	ND	870	NA	1600	7000	NA
	177SB010	710			NT		
	177SB012	52			ND		
	RTCSB010	58			NT		
Butylbenzylphthalate	177SB014	33	1600000	NA	ND	930000	NA
	177SB016	79			ND		

Table 10.12.4
SWMU 177/RTC
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Di-n-butylphthalate	177SB005	39	780000	NA	ND	2300000	NA
	RTCSB001	58			NT		
	RTCSB002	89.5			NT		
	RTCSB004	97			NT		
	RTCSB005	82			NT		
	RTCSB006	64			NT		
	RTCSB009	45			NT		
	RTCSB010	73			NT		
Diethylphthalate	177SB004	ND	6300000	NA	48	230000	NA
bis(2-Ethylhexyl)phthalate (BEHP)	177SB005	45	46000	NA	ND	1800000	NA
	177SB006	100			87		
	177SB007	770			87		
	177SB010	230			NT		
	177SB016	110			ND		
	177SB018	49			ND		
	RTCSB003	270			NT		
	RTCSB010	89			NT		
Fluoranthene	177SB007	ND	310000	NA	700	2100000	NA
	177SB010	1400			NT		
	177SB012	200			ND		
	177SB013	33			ND		

Table 10.12.4
SWMU 177/RTC
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Fluoranthene (Continued)	177SB014	26			ND		
	177SB016	43			ND		
	177SB018	85			ND		
	RTCSB010	220			NT		
Phenanthrene	177SB007	ND	230000	NA	110	660000	NA
	177SB010	790			NT		
	177SB012	160			ND		
	RTCSB010	80			NT		
Pyrene	177SB007	ND	230000	NA	740	2100000	NA
	177SB010	1700			NT		
	177SB012	140			ND		
	177SB013	22			ND		
	177SB014	18			ND		
	177SB016	37			ND		
	177SB018	73			ND		
	RTCSB010	180			NT		
Pesticides/PCBs (μg/kg)							
Aroclor-1260	RTCSB008	33	320	NA	NT	1000	NA
	RTCSB010	190			NT		

Table 10.12.4
SWMU 177/RTC
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
delta-BHC (delta-HCH)	RTCSB010	0.9	350	NA	NT	1.8	NA
Chlordane	RTCSB003	40	1800	NA	NT	5000	NA
	RTCSB006	130			NT		
	RTCSB009	57			NT		
	RTCSB010	680			NT		
alpha-Chlordane	177SB003	4.25	1800	NA	ND	5000	NA
gamma-Chlordane	177SB003	6.95	1800	NA	ND	5000	NA
	177SB007	ND			4.1		
4,4'-DDD	177SB003	6.8	2700	NA	ND	8000	NA
	RTCSB003	3.3			NT		
	RTCSB005	0.22			NT		
	RTCSB006	5.7			NT		
	RTCSB008	1.9			NT		
	RTCSB009	1.5			NT		
	RTCSB010	3.7			NT		

Table 10.12.4
SWMU 177/RTC
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
4,4'-DDE	177SB001	37	1900	NA	NT	27000	NA
	177SB003	75.5			ND		
	177SB004	3.8			ND		
	177SB005	72			12		
	177SB007	5.6			39		
	RTCSB003	57			NT		
	RTCSB006	3.9			NT		
	RTCSB008	24			NT		
	RTCSB009	16			NT		
	RTCSB010	25			NT		
4,4'-DDT	177SB001	5.6	1900	NA	NT	16000	NA
	177SB003	8.2			ND		
	177SB005	38			6		
	177SB006	2.7			ND		
	177SB007	3.8			37		
	RTCSB002	0.085			NT		
	RTCSB003	20			NT		
	RTCSB006	9.4			NT		

Table 10.12.4
SWMU 177/RTC
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
4,4'-DDT (Continued)	RTCSB008	7.9			NT		
	RTCSB009	17			NT		
	RTCSB010	23			NT		
Dieldrin	RTCSB003	3.7	40	NA	NT	2	NA
Endosulfan II	RTCSB002	0.045	47000	NA	NT	9000	NA
Endrin	RTCSB003	2.8	2300	NA	NT	500	NA
	RTCSB008	2.2			NT		
	RTCSB010	5.1			NT		
Endrin aldehyde	RTCSB010	5.2	2300	NA	NT	340	NA
Heptachlor epoxide	177SB001	2.9	70	NA	NT	330	NA
	177SB003	3.05			ND		
	RTCSB008	0.57			NT		
Methoxychlor	177SB006	ND	39000	NA	71	80000	NA
	RTCSB002	2			NT		
TPH-DRO (mg/kg)							
Diesel	177SB005	**39.6**	NA	NA	ND	NA	NA
TPH-GRO (mg/kg)							
Gasoline	177SB006	**21.2**	NA	NA	ND	NA	NA

Table 10.12.4
SWMU 177/RTC
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Dioxin Compounds (ng/kg)							
2,3,7,8-TCDD equivalents (TEQs)	177SB001	0.21	4.3	NA	NT	1600	NA
	177SB002	0.073			0.033		
	177SB003	0.64			0.045		
	177SB004	0.14			0.034		
	177SB005	1.67			0.112		
	177SB006	0.074			0.004		
	177SB007	0.028			0.049		
	RTCSB005	0.057			NT		
	RTCSB010	0.97			NT		
123478-HxCDD	177SB005	0.615	43	NA	ND	4100	NA
123678-HxCDD	177SB005	2.21	43	NA	ND	4100	NA
123789-HxCDD	177SB005	1.58	43	NA	ND	4100	NA
1234678-HpCDD	177SB001	7.53	430	NA	NT	108000	NA
	177SB002	2.97			1.58		
	177SB003	30.6			1.89		
	177SB004	6.26			1.39		

Table 10.12.4
SWMU 177/RTC
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
1234678-HpCDD (Continued)	177SB005	46.5			4.32		
	177SB006	3.84			ND		
	177SB007	1.6			2.58		
	RTCSB005	1.321			NT		
	RTCSB010	30.181			NT		
OCDD	177SB001	73.9	4300	NA	NT	1080000	NA
	177SB002	30.9			13.1		
	177SB003	262.5			16.1		
	177SB004	61.5			11.1		
	177SB005	276			24.9		
	177SB006	35.8			4.34		
	177SB007	12.1			23.4		
	RTCSB005	43.831			NT		
	RTCSB010	528.609			NT		
123678-HxCDF	177SB005	0.785	43	NA	ND	216000	NA
234678-HxCDF	177SB005	1	43	NA	0.341	216000	NA
1234678-HpCDF	177SB001	5.27	430	NA	NT	54000	NA
	177SB002	1.12			0.338		
	177SB003	6.48			0.916		
	177SB004	1.39			0.855		
	177SB005	30.7			1.74		
	RTCSB010	12.264			NT		

Table 10.12.4
SWMU 177/RTC
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
OCDF	177SB001	4.45	4300	NA	NT	540000	NA
	177SB002	0.725			0.225		
	177SB003	9.68			0.673		
	177SB004	1.04			0.464		
	177SB005	7.83			ND		
	177SB007	0.47			ND		
	RTCSB010	20.449			NT		
Inorganics (mg/kg)							
Aluminum (Al)	177SB001	1880	7800	27400	NT	560000	18900
	177SB002	990			1170		
	177SB003	2210			3320		
	177SB004	1080			2210		
	177SB005	2300			4280		
	177SB006	2430			2550		
	177SB007	4580			3900		
	RTCSB001	4290			NT		
	RTCSB002	4525			NT		
	RTCSB003	2800			NT		
	RTCSB004	4780			NT		

Table 10.12.4
SWMU 177/RTC
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Aluminum (Al) (Continued	RTCSB005	5930			NT		
	RTCSB006	1510			NT		
	RTCSB007	2610			NT		
	RTCSB008	1950			NT		
	RTCSB009	2110			NT		
	RTCSB010	2810			NT		
Arsenic (As)	177SB001	3.9	0.43	21.6	NT	15	6.45
	177SB002	4.2			2.2		
	177SB003	4.1			3.7		
	177SB004	1.3			2.6		
	177SB005	5.2			4.3		
	177SB006	2.5			2.8		
	177SB007	1.4			3		
	RTCSB002	1.675			NT		
	RTCSB003	4.6			NT		
	RTCSB004	2			NT		
	RTCSB005	2.3			NT		
	RTCSB006	0.61			NT		

Table 10.12.4
SWMU 177/RTC
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Arsenic (As) (Continued)	RTCSB007	1.2			NT		
	RTCSB008	1.9			NT		
	RTCSB009	1.57			NT		
	RTCSB010	1.5			NT		
Barium (Ba)	177SB001	7.5	550	54.2	NT	820	36
	177SB002	5.3			4		
	177SB003	8.5			7.2		
	177SB004	5.5			6.1		
	177SB005	8.6			9.7		
	177SB006	5.4			6.3		
	177SB007	5.3			10.9		
	RTCSB001	17.3			NT		
	RTCSB002	12.55			NT		
	RTCSB003	11.1			NT		
	RTCSB004	14.9			NT		
	RTCSB005	20.6			NT		
	RTCSB006	5.5			NT		
	RTCSB007	7.3			NT		
	RTCSB008	12.3			NT		
	RTCSB009	10.05			NT		
	RTCSB010	18.8			NT		

Table 10.12.4
SWMU 177/RTC
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Beryllium (Be)	177SB001	0.31	16	0.95	NT	32	0.67
	177SB002	0.25			0.25		
	177SB003	0.34			0.39		
	177SB004	0.17			0.27		
	177SB005	0.34			0.43		
	177SB006	0.19			0.3		
	177SB007	0.16			0.32		
Cadmium (Cd)	177SB001	0.26	7.8	0.61	NT	4	0.54
	177SB002	0.36			ND		
	177SB003	0.325			ND		
	177SB005	0.44			0.13		
	RTCSB008	0.4			NT		
Chromium (Cr) (total)	177SB001	7	39	34.5	NT	19	51.3
	177SB002	5.9			5.1		
	177SB003	8.75			9.4		
	177SB004	3.3			6.3		
	177SB005	12.3			13.5		
	177SB006	4.6			6.3		
	177SB007	5.8			9.2		

Table 10.12.4
SWMU 177/RTC
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Chromium (Cr) (total) (Continued)	RTCSB001	5.2			NT		
	RTCSB002	7.05			NT		
	RTCSB003	8.2			NT		
	RTCSB004	6.6			NT		
	RTCSB005	8.8			NT		
	RTCSB006	4.6			NT		
	RTCSB007	6.4			NT		
	RTCSB008	10.7			NT		
	RTCSB009	6.05			NT		
	RTCSB010	6.9			NT		
Cobalt (Co)	177SB001	2.3	470	5.8	NT	990	3.48
	177SB002	2.7			0.98		
	177SB003	2.2			1.7		
	177SB004	0.59			1.1		
	177SB005	3			1.8		
	177SB006	1.2			0.96		
	177SB007	0.56			1.3		
	RTCSB001	0.49			NT		
	RTCSB002	0.625			NT		

Table 10.12.4
SWMU 177/RTC
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Cobalt (Co) (Continued)	RTCSB003	0.72			NT		
	RTCSB004	0.65			NT		
	RTCSB005	0.51			NT		
	RTCSB006	0.85			NT		
	RTCSB007	1			NT		
	RTCSB008	1.1			NT		
	RTCSB009	1.03			NT		
	RTCSB010	0.79			NT		
Copper (Cu)	177SB001	2.3	310	240	NT	5600	11.5
	177SB002	2			0.83		
	177SB003	4.9			1.7		
	177SB004	1.1			2.2		
	177SB005	4.4			3.2		
	177SB006	1.4			1.2		
	177SB007	3.2			3.6		
	RTCSB001	1.4			NT		
	RTCSB002	3.95			NT		
	RTCSB003	112			NT		
	RTCSB004	5.9			NT		

Table 10.12.4
SWMU 177/RTC
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Copper (Cu) (Continued)	RTCSB005	1.7			NT		
	RTCSB006	1.5			NT		
	RTCSB007	2			NT		
	RTCSB008	8.3			NT		
	RTCSB009	1.3			NT		
	RTCSB010	9.2			NT		
Cyanide	177SB002	0.22	160	ND	ND	20	ND
	177SB005	0.24			ND		
Lead (Pb)	177SB001	4.9	400	203	NT	400	12.3
	177SB002	2.5			1.7		
	177SB003	9.1			3.8		
	177SB004	3.2			4.6		
	177SB005	7			5.5		
	177SB006	2.7			2.5		
	177SB007	5.9			13.1		
	RTCSB001	14.7			NT		
	RTCSB002	11.6			NT		
	RTCSB003	23.5			NT		
	RTCSB004	7.9			NT		

Table 10.12.4
SWMU 177/RTC
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Lead (Pb) (Continued)	RTCSB005	4.3			NT		
	RTCSB006	4.3			NT		
	RTCSB007	3.8			NT		
	RTCSB008	83.6			NT		
	RTCSB009	3.5			NT		
	RTCSB010	44.7			NT		
Manganese (Mn)	177SB001	85.8	160	419	NT	480	118
	177SB002	111			29.8		
	177SB003	82.5			56		
	177SB004	32.3			25.8		
	177SB005	118			50		
	177SB006	22.2			37.5		
	177SB007	12.2			34.2		
	RTCSB001	14.6			NT		
	RTCSB002	17.2			NT		
	RTCSB003	27.4			NT		
	RTCSB004	14.5			NT		
	RTCSB005	10.2			NT		
	RTCSB006	27.7			NT		

Table 10.12.4
SWMU 177/RTC
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Manganese (Mn) (Continued)	RTCSB007	30.7			NT		
	RTCSB008	36.1			NT		
	RTCSB009	27.8			NT		
	RTCSB010	22.1			NT		
Mercury (Hg)	177SB005	ND	2.3	0.47	0.21	1	ND
	RTCSB009	0.26			NT		
Nickel (Ni)	177SB001	5	160	23.9	NT	65	15.7
	177SB002	5.1			1.9		
	177SB003	5.5			2.8		
	177SB004	1.1			1.9		
	177SB005	7.6			4		
	177SB006	1.2			1.8		
	177SB007	1.5			2.8		
	RTCSB001	1.2			NT		
	RTCSB002	2.35			NT		
	RTCSB003	2.1			NT		
	RTCSB004	1.4			NT		
	RTCSB005	1.4			NT		
	RTCSB006	0.99			NT		

Table 10.12.4
SWMU 177/RTC
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Nickel (Ni)	RTCSB007	1.1			NT		
	RTCSB008	2.2			NT		
	RTCSB009	1.2			NT		
	RTCSB010	1.7			NT		
Selenium (Se)	RTCSB002	0.78	39	1.49	NT	2.6	1.77
	RTCSB004	0.56			NT		
	RTCSB008	0.61			NT		
Tin (Sn)	177SB001	2.4	4700	7.5	NT	5500	ND
	177SB003	ND			2.9		
	177SB004	ND			2.5		
	177SB005	ND			2.6		
	177SB007	ND			3		
Vanadium (V)	177SB001	6.1	55	113	NT	3000	38.1
	177SB002	3.8			4.3		
	177SB003	7.4			8.8		
	177SB004	3.1			6.2		
	177SB005	9.5			10.7		
	177SB006	5.7			6.1		
	177SB007	4.5			8.8		

Table 10.12.4
SWMU 177/RTC
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Vanadium (V) (Continued)	RTCSB001	7.1			NT		
	RTCSB002	11.65			NT		
	RTCSB003	8.8			NT		
	RTCSB004	13			NT		
	RTCSB005	13.7			NT		
	RTCSB006	4.6			NT		
	RTCSB007	6.9			NT		
	RTCSB008	10.1			NT		
	RTCSB009	7.35			NT		
	RTCSB010	6			NT		
Zinc (Zn)	177SB001	16.2	2300	206	NT	6200	36.2
	177SB002	14			6.8		
	177SB003	36.45			12		
	177SB004	8.2			13.8		
	177SB005	36.9			43.7		
	177SB006	8.3			9.2		
	177SB007	18.2			40.9		
	RTCSB001	14.1			NT		
	RTCSB002	16.8			NT		
	RTCSB003	52.5			NT		

Table 10.12.4
SWMU 177/RTC
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)	Subsurface Background
Zinc (Zn) (Continue)	RTCSB004	11.6			NT		
	RTCSB005	5.1			NT		
	RTCSB006	13.4			NT		
	RTCSB007	16.4			NT		
	RTCSB008	137			NT		
	RTCSB009	14.65			NT		
	RTCSB010	60.3			NT		

Notes:

a	=	Background value for non clay samples
*	=	Residential RBCs (THQ=0.1) were used as a reference concentration for upper-interval samples. Generic soil-to groundwater SSLs (DAF=10) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996b) were used as s reference concentration for lower-interval samples

Bold concentrations exceed both the RBC and the zone background.
All background values for Zone I are based on twice the means of the grid sample concentrations. Background values for the groundwater are based on two sampling rounds in two wells at each depth

GW	=	Groundwater
NA	=	Not applicable/not available
ND	=	Not detected
NT	=	Not taken
RBC	=	Risk-based concentration
SSL	=	Soil screening level
Ng/kg	=	Nanograms per kilogram
mg/kg	=	Micrograms per kilogram
μG/L	=	Micrograms per liter
DAF	=	Dilution Attenuation Factor
THQ	=	Target Hazard Quotient

Volatile Organic Compounds in Soil

Twelve VOCs were detected in surface soil samples at SWMU 177/RTC. Acetone was detected in seven of 29 samples at concentrations ranging from 8.0 μg/kg to 160 μg/kg. Similarly xylene was detected in five of 29 samples at concentrations ranging from 4.3 μg/kg to 7.9 μg/kg. None of these detections exceeded its RBC. No VOCs were detected in the surface soil sample from grid-based boring GDI016.

Eight VOCs were detected in the subsurface soil samples at SWMU 177/RTC. Again, acetone and xylene had the greatest frequency of detections. Methylene chloride exceeded its SSL (10 μg/kg) in sample 177SB003 at 15 μg/kg. No other VOCs detected in the subsurface soils exceeded their SSLs.

Semivolatile Organic Compounds in Soil

Seventeen SVOCs were detected in the surface soil samples at SWMU 177/RTC. Benzo(a)anthracene exceeded its RBC (870 μg/kg) in boring 177SB010 at 910 μg/kg. Benzo(a)pyrene exceeded its RBC (87 μg/kg) in boring 177SB010 at 1,000 μg/kg and in boring RTCSB010 at 140 μg/kg. Benzo(b)fluoranthene exceeded its RBC in on sample in boring 177SB010 at 1,000 μg/kg. No other SVOCs exceeded their RBCs. No SVOCs were detected in the surface soil sample from grid-boring GDISB016.

In accordance with recent cPAH guidance and Section 7 of this report, BEQs were calculated for cPAHs at SWMU 177/RTC. BEQs were calculated for seven surface soil samples at concentrations ranging from 2.42 μg/kg to 1,274 μg/kg. The calculated BEQs exceeded their RBC in boring 177SB010 (1,274 μg/kg), 177SB012 (98.5 μg/kg), and RTCSB010 (182 μg/kg).

Fourteen SVOCs were detected in subsurface soil samples at SWMU 177/RTC. Benzo(a)anthracene was detected in one sample in boring 177SB007 at 860 μg/kg, which exceeds the SSL of 800 μg/kg. No other SVOCs exceeded their SSLs.

BEQs were caclulated for one subsurface soil sample. Boring 177SB007 had a calculated BEQ of 2,878 μg/kg, which exceeded its SSL of 1,600 μg/kg. cPAHs were not detected in any other subsurface soil samples.

Pesticides and PCBs in Soil

Thirteen pesticides were detected in surface soils at SWMU 177/RTC. The most frequently detected was 4,4'DDT which was detected in 11 of 17 samples. The detections ranged from 0.085 μg/kg to 35 μg/kg, which were both below the RBC. 4,4'DDE was detected in 10 of 17 samples, at concentrations ranging from 3.8 μg/kg to 75.5 μg/kg, which are also below the RBC. 4,4'DDE was also detected in a surface soil sample from grid boring GDI016 at 19 μg/kg. None of the pesticides detected exceeded its RBC.

Four pesticides were detected in subsurface soil samples. None exceeded its SSL.

Aroclor-1260 was detected in two surface soil samples at concentrations of 33 μg/kg, and 190 μg/kg which are below its RBC.

Other Organic Compounds in Soil

Dioxins were detected in all nine surface soil samples collected and analyzed for dioxins. In accordance with recent dioxin guidance and Section 7 of this report, TEQs were calculated for dioxins in soil. Calculated TEQs ranged from 2.86E-5 μg/kg to 1.67E-3 μg/kg, which are all below the RBC of 4.3E-3 μg/kg.

Dioxins were also detected in all six subsurface soil samples collected. The calculated TEQs ranged from 4.34E-6 μg/kg to 1.20E-4, which are well below the SSL of 1.6 μg/kg.

Inorganics in Soil

Seventeen inorganics were detected in soil. None exceeded its RBC or SSL and background. Additionally, nine inorganics were detected in the surface soil sample from grid-based boring GDI016. None exceeded its RBC.

10.12.3 Groundwater Sampling and Analysis

To characterize the site groundwater and to help fill in potential data gaps, two shallow monitoring wells were installed and sampled at SWMU 177/RTC, and two rounds of groundwater sampling were completed. During the first-round of sampling, SWMU 177/RTC wells were sampled for VOCs and SVOCs at DQO Level III. Samples from the second-round were analyzed for metals, VOCs, SVOCs. Table 10.12.5 summarizes the groundwater sampling at SWMU 177/RTC.

Table 10.12.5
SWMU 177/RTC
Groundwater Sampling Summary

Sampling Round	Sampling Date	Wells Sampled	Sample Analyses
1	04/15/98	177001 177002	VOCs, SVOCs
2	08/17/98	177001 177002	VOCs, SVOCs, metals

Groundwater samples were also collected from a shallow/deep grid monitoring well pair (GDI016/GDI16D) located near SWMU 177/RTC. Both were sampled during four sampling events, and all samples were analyzed for the standard suite of parameters, plus chloride, sulfate, and TDS. Results are discussed in the SWMU 177/RTC nature and extent section and presented in Appendix D.

Figure 10.12.1 illustrates SWMU 177/RTC monitoring well locations. All shallow monitoring wells were installed between 12.5-13.0 feet bgs in the upper sand layer of the Wando Formation. Deep grid well GDI16D was installed at 64.5 feet bgs. All wells were installed in accordance with Section 3.2.3 of this report.

10.12.4 Nature and Extent of Contamination in Groundwater

Table 10.12.6 summarizes the SWMU 177/RTC groundwater organic analytical results. Table 10.12.7 summarizes groundwater inorganic analytical results. Table 10.12.8 summarizes all analytes detected in shallow groundwater at SWMU 177/RTC. Appendix D is a complete analytical data report for all samples collected in Zone I.

Volatile Organic Compounds in Groundwater

One VOC, carbon disulfide, was detected during the first sampling round at well 177001 (0.52 μg/L). No other VOCs were detected during any of the sampling rounds.

Ethylbenzene (3.0 μg/L), 2-Butanone (3.0 μg/L) and xylene (6.0 μg/L) were detected in the shallow grid-based well, GDI016 during the first-round of sampling. All were below their tap-water RBCs. Methylene chloride (27.0 μg/L) and acetone (64.0 μg/L) were detected in the duplicate sample from GDI016 during the second-round of sampling. Methylene chloride exceeded its tap-water RBC. No other VOCs were detected in shallow grid well GDI016.

No VOCs were detected in the deep grid-based monitoring well, GDI16D, during any of the sampling rounds.

Table 10.12.6
SWMU 177/RTC
Organic Compound Analysis Results for Groundwater (μg/L)

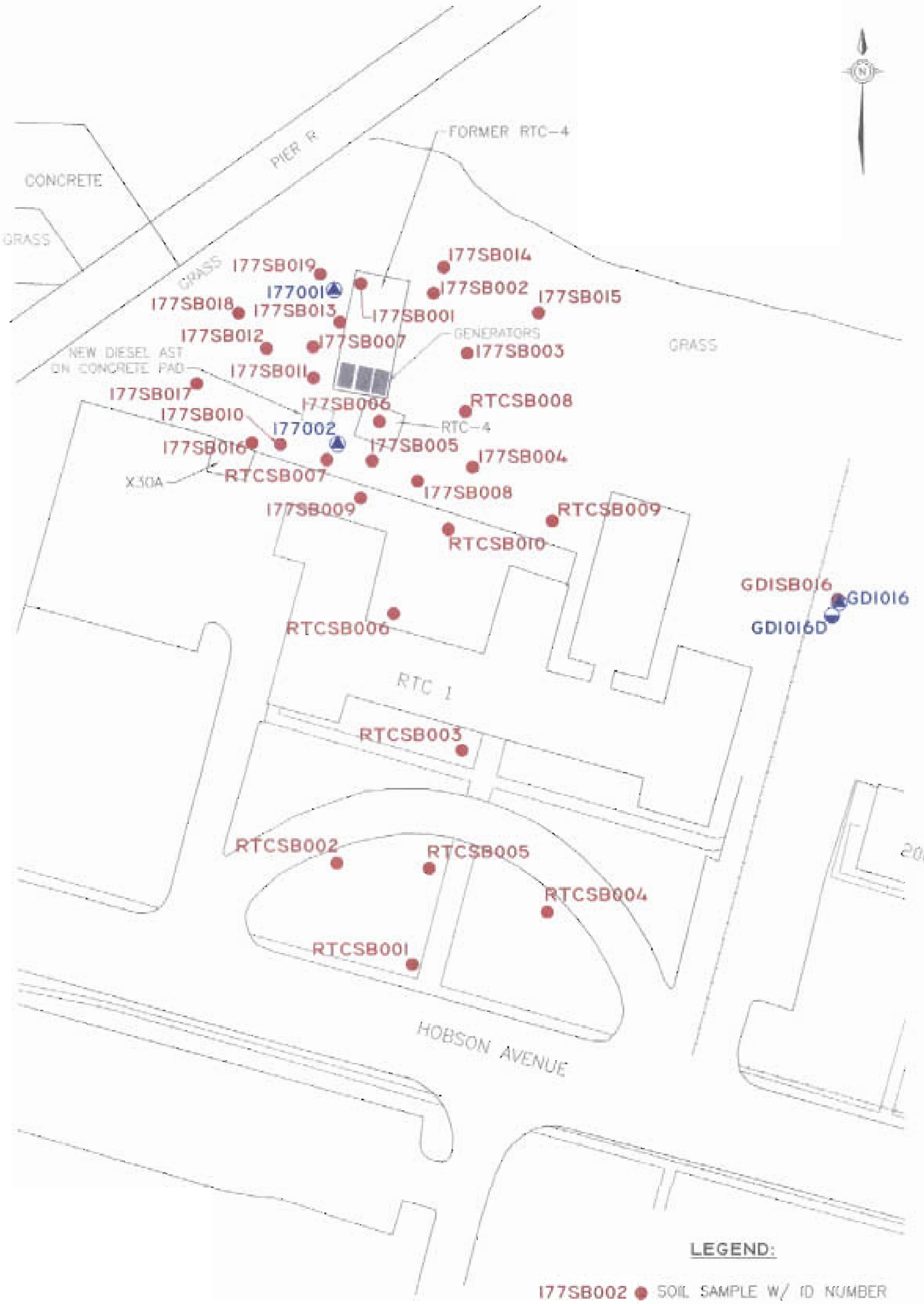
Parameters	Sample Round	Detection Frequency	Detection Range	Mean	Tap-water RBC/MCL	Number of Samples Exceeding RBC or MCL
Volatile Organics Compounds						
Carbon disulfide	First	1/2	0.52	0.52	100/NL	0
	Second	0/2	ND	ND		0
Semivolatile Organics Compounds						
Acenaphthene	First	1/2	1.9	1.9	220/NA	0
	Second	1/2	1.0	1.0		0

Notes:
NA = Not Applicable/Not Available/Not Analyzed
ND = Not Detected
NL = Not Listed
μg/kg = Micrograms per kilogram
μg/L = Micrograms per liter
See Table 5.5 for organic compound screening concentrations and their sources.

Table 10.12.7
SWMU 177/RTC
Inorganic Analysis Results for Groundwater (μg/L)

Parameters	Sample Round	Detection Frequency	Detection Range	Mean	Tap-water RBC/MCL	Shallow Groundwater Background	Number of Samples Exceeding Lower of RBC or MCL and Background
Arsenic (As)	First	NA	NA	NA	0.045/50	23.0	NA
	Second	2/2	1.5 - 2.1	1.8			0
Manganese (Mn)	First	NA	NA	NA	73/NL	5,430	NA
	Second	2/2	44.4 - 270	157			0

Notes:
NA = Not Applicable/Not Available
NL = Not Listed
μg/L = micrograms per liter
See Table 5.6 for inorganic screening concentrations and their sources.



LEGEND:

177SB002 ● SOIL SAMPLE W/ ID NUMBER

GDI016 MONITORING WELL W/ ID NUMBER

GDI16D DEEP MONITORING WELL W/ ID NUMBER

0 50 100 200

SCALE IN FEET

ZONE I
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.12.1
SWMU 177 AND
RTC AREA
SAMPLING LOCATIONS

Table 10.12.8
SWMU 177/RTC
Analytes Detected in Shallow Groundwater

Parameter	Location	1st Quarter	2nd Quarter	Tap-water RBC*	MCL/SMCL*	Shallow Background
Volatile Organic Compounds ($\mu g/L$)						
Carbon disulfide	177GW001	0.52	ND	100	NA	
Semivolatile Organic Compounds ($\mu g/L$)						
Acenaphthene	177GW001	1.9	1	220	NA	
Inorganics (mg/L)						
Arsenic (As)	177GW001	NT	1.5	0.045	50	23
	177GW002	NT	2.1			
Manganese (Mn)	177GW001	NT	270	73	NL	5430
	177GW002	NT	44.4			

Notes:
* = Tap-water RBCs (THQ=0.1) from *Risk-Based Concentration Table* (USEPA, October 22, 1997), and MCLs/SMCLs from *Drinking Water Regulations and Health Advisories* (USEPA, 1996e)
All background values for Zone I are based on twice the means of the grid sample concentrations. Background values for the groundwater are based on two sampling rounds in two wells at each depth.
NA = Not Applicable/Not Available
ND = Not Detected
NL = Not listed
NT = Not taken
RBC = Risk-based concentration
μG/l = Micrograms per liter
mg/L = Milligrams per liter

Semivolatile Organic Compounds in Groundwater

Acenaphthene was detected in the shallow groundwater at in well 177001 in both the first and second-round of sampling at concentrations below the tap-water RBC. Acetophenone (1.0 μg/L) and naphthalene (2.0 μg/L) were detected in the shallow grid-based well in the first and second-round of sampling respectively. Acetophenone exceeded its tap-water RBC of 0.0042 μg/L. No other SVOCs were detected in the shallow groundwater at SWMU 177/RTC. No SVOCs were detected in the deep grid-based well (GDI16D).

Other Organic Compounds

Dioxins were detected in a deep groundwater sample from grid-based well GDI16D during the second and third-rounds of sampling. Calculated TEQs, are 0.013 pg/L (second-round) and 0.351 pg/L for the third-round. These calculated values are below their tap-water RBCs. No other dioxins were detected in the grid-based pair. Samples from the site wells were not analyzed for dioxins.

Inorganics in Groundwater

Two inorganics – arsenic and manganese – were detected in the shallow groundwater at SWMU 177/RTC. These detections did not exceed the inorganics screening levels.

Aluminum was detected in one sample from the shallow grid-based well GDI016 during the third-round of sampling at 33.7 μg/L. Aluminum was not detected in any other shallow well samples, nor was it detected in any of the deep grid-based well samples from GDI16D. Barium was detected in shallow grid well GDI016 in the first, second, and fourth sampling rounds at concentrations ranging from 2.5 μg/L to 7.1 μg/L, which are below the tap-water RBC and shallow background value. Barium was also detected in the deep grid-based well GDI16D in all four rounds of sampling. The detections ranged from 48.4 μg/L to 68.3 μg/L, which are below the MCL and deep groundwater background values. Beryllium was detected in one deep well sample from GDI16D during the second-round of sampling, at 1.1 μg/L, which is below the MCL and deep groundwater background value. Copper was detected in one deep well sample in the first-round from GDI16D at 1.8 μg/L which is below the MCL. Lead was detected in one shallow groundwater sample from GDI016 during the first-round of sampling at 2.9 μg/L which is below the tap-water RBC and shallow groundwater background. Manganese was detected in all four rounds of samples from the shallow grid-based well at detections ranging from 93.1 μg/L to 172.5 μg/L. These values are below the tap-water RBC and the shallow groundwater background. Manganese was also detected in all four rounds of samples from the deep grid-based well GDI16D. Detections ranged from 56.0 μg/L to 110 μg/L, which are below the deep groundwater background. Nickel was detected in one shallow groundwater sample from GDI016 during the fourth-round at 1.1 μg/L and from the deep grid-based well, GDI16D at 1.4 μg/L in the first-round. These detections are below their respective values. Zinc was detected in two shallow groundwater samples from the grid-based well GDI016 in the first and fourth-rounds at concentrations below the tap-water RBC and shallow background and from one sample from the deep grid-based well GDI16D in the first-round. This detection was below the deep groundwater background value.

10.12.5 Fate and Transport Assessment

The SWMU 177/RTC was not addressed in the *Final Zone I RFI Work Plan* (E/A&H, February 1995). This site was determined by USEPA Region IV to warrant limited investigation in conjunction with current construction activities. SWMU 177/RTC consisted of two adjacent buildings, both designated as Building RTC-4. The original RTC-4 was a 24 x 60 foot metal structure used to house heavy equipment including backhoes and trackhoes. The designation RTC-4 was given to a newer building constructed next to the former RTC-4. The newer RTC-4 was used to store lawn mowers and other lawn maintenance equipment. This unit was designated as a SWMU due to oil spillage associated with operations at the two buildings. Visual inspections during the RFA identified several areas of stained soil and concrete in and around the two buildings. These buildings were both less than 50 feet from the Cooper River. Environmental media sampled as part of this investigation include surface and subsurface soil, and shallow groundwater. Potential constituent migration pathways evaluated for SMWU 177/RTC include soil-to-groundwater, migration of groundwater to human receptors and to surface water receptors, and emission of volatiles from surface soil-to-air.

10.12.5.1 Soil-to-Groundwater Cross-Media Transport

Tables 10.12.9 and 10.12.10 compare maximum detected organic and inorganic constituent concentrations respectively in surface soil and subsurface soil samples to risk-based soil screening levels considered protective of groundwater. Maximum concentrations in soil are compared to leachability-based generic SSLs. Soil background values for Zone I inorganics were determined, but at the request of SCDHEC, they were not considered during initial comparisons of maximum soil concentrations to SSLs. To provide a conservative screen, generic SSLs are used; leachate entering the aquifer is assumed to be diluted by a ratio of 10:1, with no attenuation of constituents in soil (DAF=10).

No inorganic constituents exceeded SSLs in site soil. Five organic constituents were detected in surface and subsurface soil at levels exceeding their SSL: methylene chloride, 1,1,2,2 tetrachlorethane, benzo(a)pyrene equivalents (BEQs), benzo(a)anthracene, and dieldrin . Methylene chloride was detected in two surface samples (one SSL exceedance) and exceeded the SSL in one co-located subsurface sample. Figure 10.12.2 presents methylene chloride concentrations detected at SWMU 177/RTC. 1,1,2,2 tetrachlorethane exceeded the SSL in only one subsurface sample. Figure 10.12.3 presents tetrachlorethane exceedance at SWMU 177/RTC. The dominant BEQ species was benzo(a)pyrene, which exhibited higher concentrations in the subsurface. Figure 10.12.4 presents BEQ concentrations detected at SWMU 177/RTC. Benzo(a)anthracene had four detections (one SSL exceedance) and one subsurface exccedance. Figure 10.12.5 presents benzo(a)anthracene concentrations detected at SWMU 177/RTC. Dieldrin exhibited only one exceedance in surface soil. Figure 10.12.6 presents dieldrin concentrations detected at SWMU 177/RTC. No organic constituents were detected in shallow groundwater.

Table 10.12.9
Organic Chemicals Detected in Surface Soil, Subsurface Soil, Sediment, and Shallow Groundwater
Comparison to Cross-Media SSLs, Tap-Water RBCs, and Saltwater Surface Water Chronic Screening Levels
Charleston Naval Complex SWMU 177/RTC
Charleston, South Carolina

Parameter	Maximum Concentration Surface Soil	Subsurface Soil	Sediment	Surface Water	Screening Concentration Soil to GW SSL		Soil to Air SSL	Tap Water RBC	Saltwater Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Volatilization Potential	Groundwater Migration Concern	Surface Water Migration Concern
Volatile Organic Compounds															
Acetone	160	130	NA	ND	8000		1.0E+08	3700	NA	μG/KG	μG/L	NO	NO	NO	NO
Benzene c	0.84	ND	NA	ND	15		800	0.36	109	μG/KG	μG/L	NO	NO	NO	NO
2-Butanone (MEK)	3	27	NA	ND	3900	a	NA	1900	NA	μG/KG	μG/L	NO	NO	NO	NO
Carbon disulfide	ND	4	NA	0.52	16000		720000	1000	NA	μG/KG	μG/L	NO	NO	NO	NO
1,1-Dichloroethene c	2	ND	NA	ND	30		70	0.044	2240	μG/KG	μG/L	NO	NO	NO	NO
1,2-Dichloroethene (total)	6	6.7	NA	ND	200		1100000	55	NA	μG/KG	μG/L	NO	NO	NO	NO
Ethylbenzene	1.8	1.1	NA	ND	6500		400000	1300	4.3	μG/KG	μG/L	NO	NO	NO	NO
Methylene chloride c	12	15	NA	ND	10		13000	4.1	2560	μG/KG	μG/L	YES	NO	NO	NO
4-Methyl-2-Pentanone (MIBK)	6	ND	NA	ND	6700	a	NA	2900	NA	μG/KG	μG/L	NO	NO	NO	NO
1,1,2,2-Tetrachloroethane c	2	ND	NA	ND	1.5		600	0.053	90.2	μG/KG	μG/L	YES	NO	NO	NO
Toluene	1.9	0.77	NA	ND	6000		650000	750	37	μG/KG	μG/L	NO	NO	NO	NO
Trichloroethene (TCE) c	3	ND	NA	ND	30		5000	1.6	NA	μG/KG	μG/L	NO	NO	NO	NO
Xylene (total)	7.9	4.7	NA	ND	70000	a	410000	12000	NA	μG/KG	μG/L	NO	NO	NO	NO
Semivolatile Organic Compounds															
Acenaphthene	98	ND	NA	1.9	290000		NA	2200	9.7	μG/KG	μG/L	NO	NO	NO	NO
Acenaphthylene	ND	150	NA	ND	96000	a	NA	1500	NA	μG/KG	μG/L	NO	NO	NO	NO
Anthracene	140	170	NA	ND	5900000		NA	11000	NA	μG/KG	μG/L	NO	NO	NO	NO
Benzoic acid	1200	240	NA	ND	200000		NA	150000	NA	μG/KG	μG/L	NO	NO	NO	NO
Benzo(g,h,i)perylene	650	1300	NA	ND	1.2E+08	a	NA	1500	NA	μG/KG	μG/L	NO	NO	NO	NO
Benzo(a)pyrene Equivalents	1274	2878	NA	ND	1600	a	NA	0.0092	NA	μG/KG	μG/L	YES	NO	NO	NO
Benzo(a)anthracene c	910	860	NA	ND	800		NA	0.092	NA	μG/KG	μG/L	YES	NO	NO	NO
Benzo(a)pyrene c	1000	2000	NA	ND	4000		NA	0.0092	NA	μG/KG	μG/L	NO	NO	NO	NO
Benzo(b)fluoranthene c	1000	ND	NA	ND	2500		NA	0.092	NA	μG/KG	μG/L	NO	NO	NO	NO
Benzo(k)fluoranthene c	1100	3100	NA	ND	25000		NA	0.92	NA	μG/KG	μG/L	NO	NO	NO	NO
Chrysene c	1000	1000	NA	ND	80000		NA	9.2	NA	μG/KG	μG/L	NO	NO	NO	NO
Dibenz(a,h)anthracene c	ND	600	NA	ND	800		NA	0.0092	NA	μG/KG	μG/L	NO	NO	NO	NO
Indeno(1,2,3-cd)pyrene c	710	1600	NA	ND	7000		NA	0.092	NA	μG/KG	μG/L	NO	NO	NO	NO
Butylbenzylphthalate	79	ND	NA	ND	930000		930000	7300	29.4	μG/KG	μG/L	NO	NO	NO	NO
Di-n-butylphthalate	97	ND	NA	ND	2300000		2300000	3700	3.4	μG/KG	μG/L	NO	NO	NO	NO
Diethylphthalate	ND	48	NA	ND	230000		2000000	29000	75.9	μG/KG	μG/L	NO	NO	NO	NO
bis(2-Ethylhexyl)phthalate (BEHP) c	770	87	NA	ND	1800000		31000000	4.8	NA	μG/KG	μG/L	NO	NO	NO	NO
Fluoranthene	1400	700	NA	ND	2100000		NA	1500	1.6	μG/KG	μG/L	NO	NO	NO	NO
Phenanthrene	790	110	NA	ND	660000	a	NA	1100	NA	μG/KG	μG/L	NO	NO	NO	NO
Pyrene	1700	740	NA	ND	2100000		NA	1100	NA	μG/KG	μG/L	NO	NO	NO	NO

Table 10.12.9
Organic Chemicals Detected in Surface Soil, Subsurface Soil, Sediment, and Shallow Groundwater
Comparison to Cross-Media SSLs, Tap-Water RBCs, and Saltwater Surface Water Chronic Screening Levels
Charleston Naval Complex SWMU 177/RTC
Charleston, South Carolina

Parameter	Maximum Concentration				Screening Concentration										
	Surface Soil	Subsurface Soil	Sediment	Surface Water	Soil to GW SSL		Soil to Air SSL	Tap Water RBC	Saltwater Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Volatilization Potential	Groundwater Migration Concern	Surface Water Migration Concern
Pesticides/PCBs															
Aroclor-1260 c	190	ND	NA	ND	1000		1000	0.033	0.03	µG/KG	µG/L	NO	NO	NO	NO
delta-BHC (delta-HCH) c	0.9	ND	NA	ND	1.8	a	NA	0.037	NA	µG/KG	µG/L	NO	NO	NO	NO
Chlordane c	680	ND	NA	ND	5000		20000	0.19	0.004	µG/KG	µG/L	NO	NO	NO	NO
alpha-Chlordane c	4.25	ND	NA	ND	5000	b	20000	0.19	0.004	µG/KG	µG/L	NO	NO	NO	NO
gamma-Chlordane c	6.95	4.1	NA	ND	5000	b	20000	0.19	0.004	µG/KG	µG/L	NO	NO	NO	NO
4,4'-DDD c	6.8	ND	NA	ND	8000		NA	0.28	0.025	µG/KG	µG/L	NO	NO	NO	NO
4,4'-DDE c	75.5	39	NA	ND	27000		NA	0.2	0.14	µG/KG	µG/L	NO	NO	NO	NO
4,4'-DDT c	38	37	NA	ND	16000		1E+09	0.2	0.001	µG/KG	µG/L	NO	NO	NO	NO
Dieldrin c	3.7	ND	NA	ND	2		1000	0.0042	0.0019	µG/KG	µG/L	YES	NO	NO	NO
Endosulfan II	0.045	ND	NA	ND	9000	b	NA	220	0.0087	µG/KG	µG/L	NO	NO	NO	NO
Endrin	5.1	ND	NA	ND	500		NA	11	0.0023	µG/KG	µG/L	NO	NO	NO	NO
Endrin aldehyde	5.2	ND	NA	ND	340	a	NA	11	NA	µG/KG	µG/L	NO	NO	NO	NO
Heptachlor epoxide c	3.05	ND	NA	ND	330		5000	0.0012	0.0036	µG/KG	µG/L	NO	NO	NO	NO
Methoxychlor	2	71	NA	ND	80000		NA	180	0.03	µG/KG	µG/L	NO	NO	NO	NO
TPH-DRO															
Diesel	39.6	ND	NA	ND	NA		NA	NA	NA	µG/KG	µG/L	NO	NO	NO	NO
TPH-GRO															
Gasoline	21.2	ND	NA	ND	NA		NA	NA	NA	µG/KG	µG/L	NO	NO	NO	NO
Dioxin Compounds															
2,3,7,8-TCDD equivalents (TEQs) c	1.67	0.119	NA	ND	1600	a	NA	0.45	10	NG/KG	PG/L	NO	NO	NO	NO
123478-HxCDD c	0.615	ND	NA	ND	4100	a	NA	4.5	NA	NG/KG	PG/L	NO	NO	NO	NO
123678-HxCDD c	2.21	ND	NA	ND	4100	a	NA	4.5	NA	NG/KG	PG/L	NO	NO	NO	NO
123789-HxCDD c	1.58	ND	NA	ND	4100	a	NA	4.5	NA	NG/KG	PG/L	NO	NO	NO	NO
1234678-HpCDD c	46.5	4.32	NA	ND	108000	a	NA	45	NA	NG/KG	PG/L	NO	NO	NO	NO
OCDD c	529	24.9	NA	ND	1080000	a	NA	450	NA	NG/KG	PG/L	NO	NO	NO	NO
123678-HxCDF c	0.785	ND	NA	ND	216000	a	NA	4.5	NA	NG/KG	PG/L	NO	NO	NO	NO
234678-HxCDF c	1	0.341	NA	ND	216000	a	NA	4.5	NA	NG/KG	PG/L	NO	NO	NO	NO
1234678-HpCDF c	30.7	1.74	NA	ND	54000	a	NA	45	NA	NG/KG	PG/L	NO	NO	NO	NO
OCDF c	20.4	0.673	NA	ND	540000	a	NA	450	NA	NG/KG	PG/L	NO	NO	NO	NO

Notes:
Sources of screening concentrations appear in Table 5.5
Explanations of fate and transport screening procedures appear in Section 6.2

Table 10.12.10
Inorganic Chemicals Detected in Surface Soil, Subsurface Soil, Sediment, and Shallow Groundwater
Comparison to Cross-Media SSLs, Tap-Water RBCs, Saltwater Surface Water Chronic Screening Levels, and Background Values
Charleston Naval Complex SWMU 177/RTC
Charleston, South Carolina

	Maximum Concentration				Screening Concentration											
Parameter	Surface Soil	Subsurface Soil	Sediment	Shallow Ground Water	Soil to GW SSL	Soil Background	Soil to Air SSL	Tap Water RBC	Shallow GW Background	Saltwater Surf. Wtr Chronic	Soil Units	Water Units	Leaching Potential	Fugitive Particulate Inhalation Concern	Ground-water Migration Concern	Surface Water Migration Concern
Inorganic Chemicals																
Aluminum (Al)	5930	4280	NA	ND	560000 a	27400	NA	37000	1440	NA	MG/KG	µG/L	NO	NO	NO	NO
Arsenic (As) c	5.2	4.3	NA	2.1	15	21.6	750	0.045	23	36	MG/KG	µG/L	NO	NO	NO	NO
Barium (Ba)	20.6	10.9	NA	ND	820	54.2	690000	2600	110	NA	MG/KG	µG/L	NO	NO	NO	NO
Beryllium (Be)	0.34	0.43	NA	ND	32	0.95	1300	73	1.1	NA	MG/KG	µG/L	NO	NO	NO	NO
Cadmium (Cd)	0.44	0.13	NA	ND	4	0.61	1800	18	NA	9.3	MG/KG	µG/L	NO	NO	NO	NO
Chromium (Cr) (total)	12.3	13.5	NA	ND	19	51.3	270	180	14.3	50	MG/KG	µG/L	NO	NO	NO	NO
Cobalt (Co)	3	1.8	NA	ND	990 a	5.8	NA	2200	2.2	NA	MG/KG	µG/L	NO	NO	NO	NO
Copper (Cu)	112	3.6	NA	ND	5600 a	240	NA	1500	4.4	2.9	MG/KG	µG/L	NO	NO	NO	NO
Cyanide (CN)	0.24	ND	NA	ND	20	ND	NA	730	25.2	1	MG/KG	µG/L	NO	NO	NO	NO
Lead (Pb)	83.6	13.1	NA	ND	400	203	400	15	4.4	8.5	MG/KG	µG/L	NO	NO	NO	NO
Manganese (Mn)	118	56	NA	270	480 a	419	NA	730	5430	NA	MG/KG	µG/L	NO	NO	NO	NO
Mercury (Hg)	0.26	0.21	NA	ND	1	0.47	10	11	NA	0.025	MG/KG	µG/L	NO	NO	NO	NO
Nickel (Ni)	7.6	2.8	NA	ND	65	23.9	13000	730	13.3	8.3	MG/KG	µG/L	NO	NO	NO	NO
Selenium (Se)	0.78	ND	NA	ND	2.6	1.77	NA	180	ND	71	MG/KG	µG/L	NO	NO	NO	NO
Tin (Sn)	2.4	2.9	NA	ND	5500 a	7.5	NA	22000	NA	NA	MG/KG	µG/L	NO	NO	NO	NO
Vanadium (V)	13.7	10.7	NA	ND	3000	113	NA	260	14	NA	MG/KG	µG/L	NO	NO	NO	NO
Zinc (Zn)	137	43.7	NA	ND	6200	206	NA	11000	24.4	86	MG/KG	µG/L	NO	NO	NO	NO

Notes:
Sources of screening concentrations appear in Table 5.6
Explanations of fate and transport screening procedures appear in Section 6.2.
Frequency and range of detections, average detected concentrations, and number of screening concentration exceedances appear in Tables 10.12.3 and 10.12.7.

Background values for soil are shown for comparison purposes only.
Maximum groundwater concentrations are screened against which is largert tap-water RBCs or corresponding background values to determine groundwater migration concerns.

a - Calculated soil-to-groundwater SSL value (See Table 6.2)
c - Carcinogenic
GW - Groundwater

NA - Not available/Not applicable
ND - Not detected
RBC - Risk-based concentration

SSL - Soil screening level
MG/KG - Milligrams per kilogram
µG/L - Micrograms per liter

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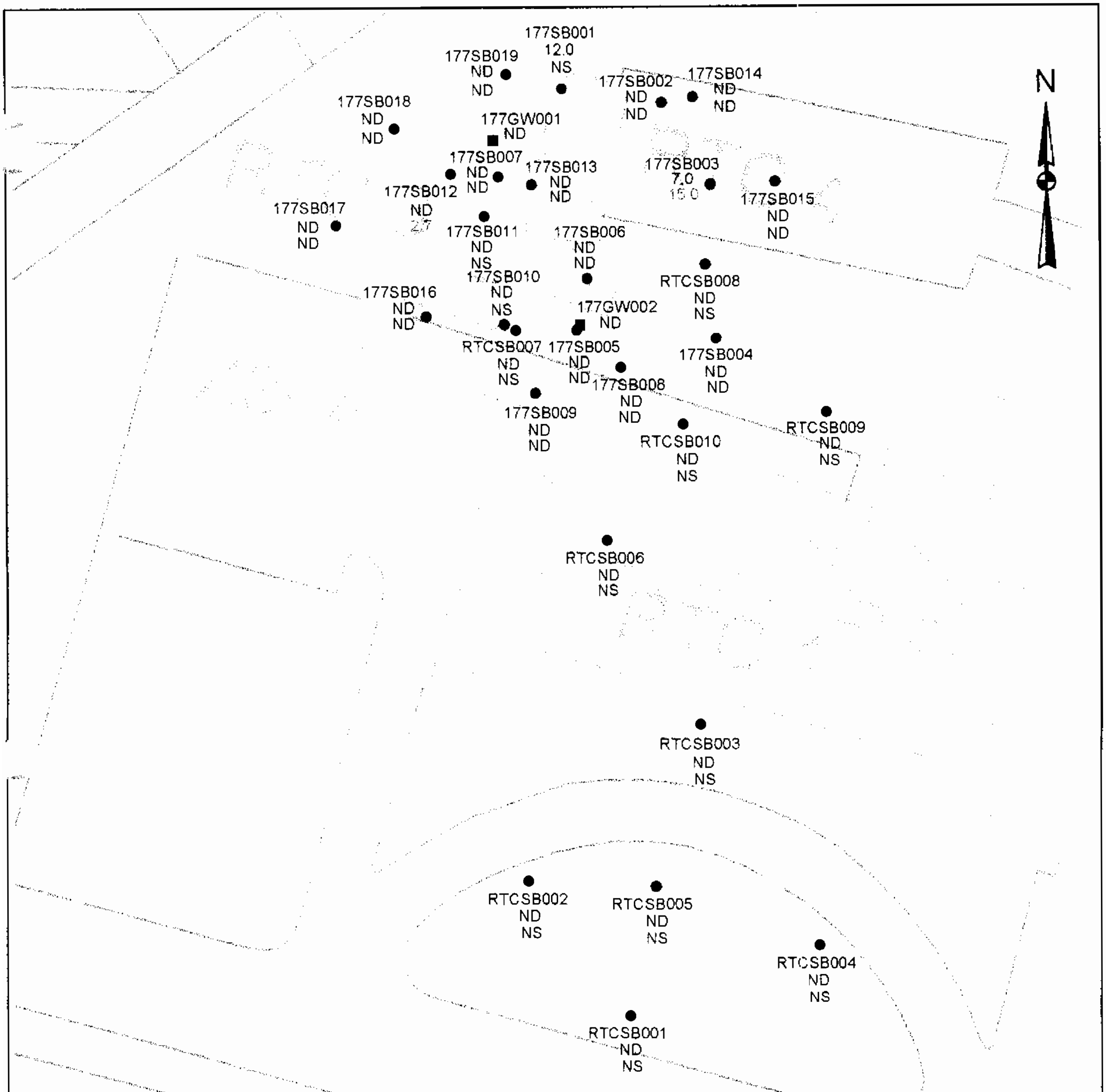


LEGEND

■	MONITORING WELL LOCATION
●	ZONE I SOIL BORING LOCATION
12.30	ZONE I SURFACE SOIL CONC. (UG/KG)
12.30	ZONE I SUBSURFACE SOIL CONC. (UG/KG)
12.30	MAXIMUM QUARTERLY GW CONC. (UG/L)
NS	NO SAMPLE TAKEN
ND	NON DETECT

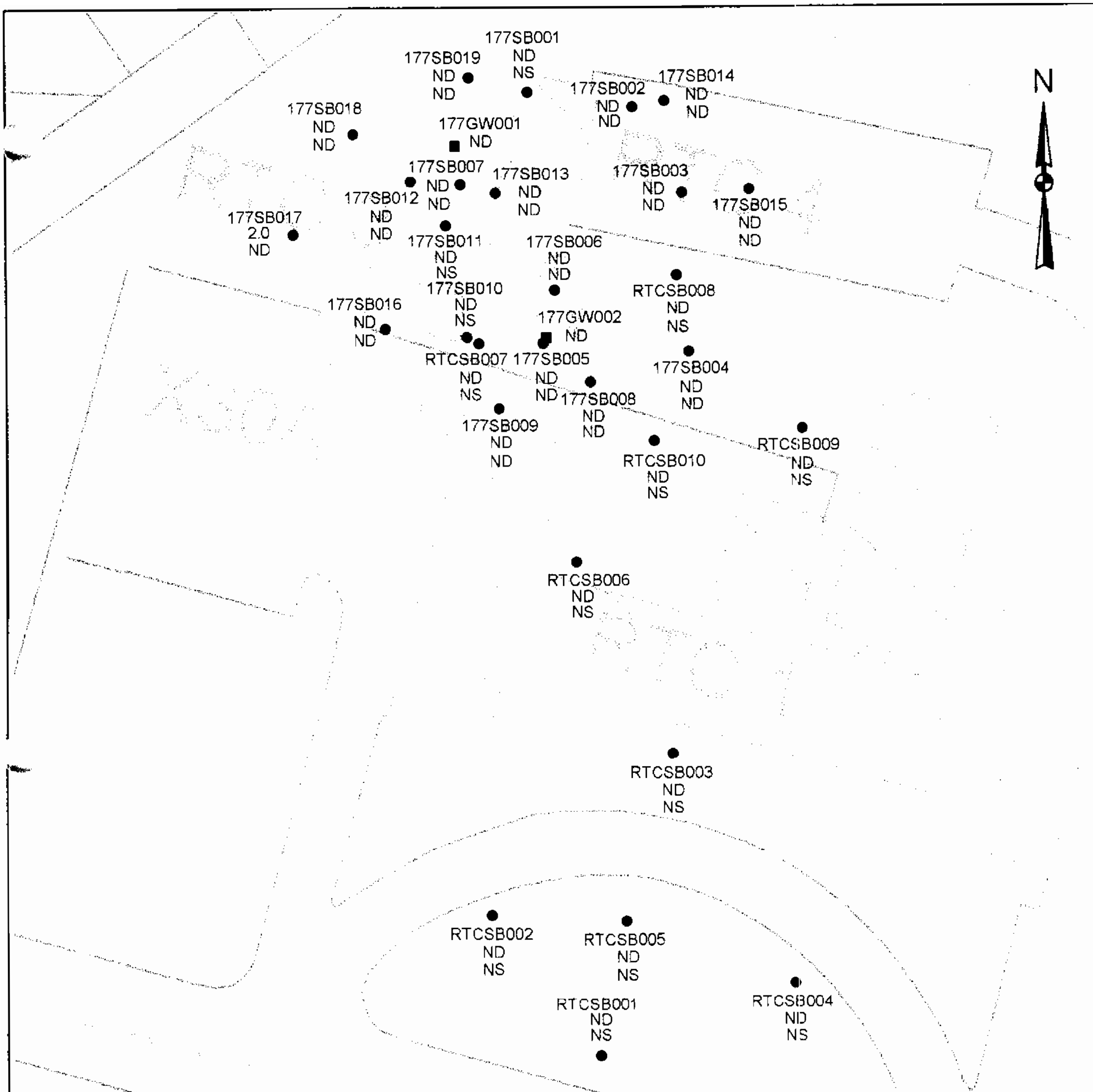
SCALE

20 0 20 40 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.12.2
ZONE I
177/RTC
METHYLENE CHLORIDE
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=NA RBC=85000 UG/KG SSL=10 UG/KG



LEGEND

■	MONITORING WELL LOCATION
●	ZONE I SOIL BORING LOCATION
12.30	ZONE I SURFACE SOIL CONC. (UG/KG)
12.30	ZONE I SUBSURFACE SOIL CONC. (UG/KG)
12.30	MAXIMUM QUARTERLY GW CONC. (UG/L)
NS	NO SAMPLE TAKEN
ND	NON DETECT

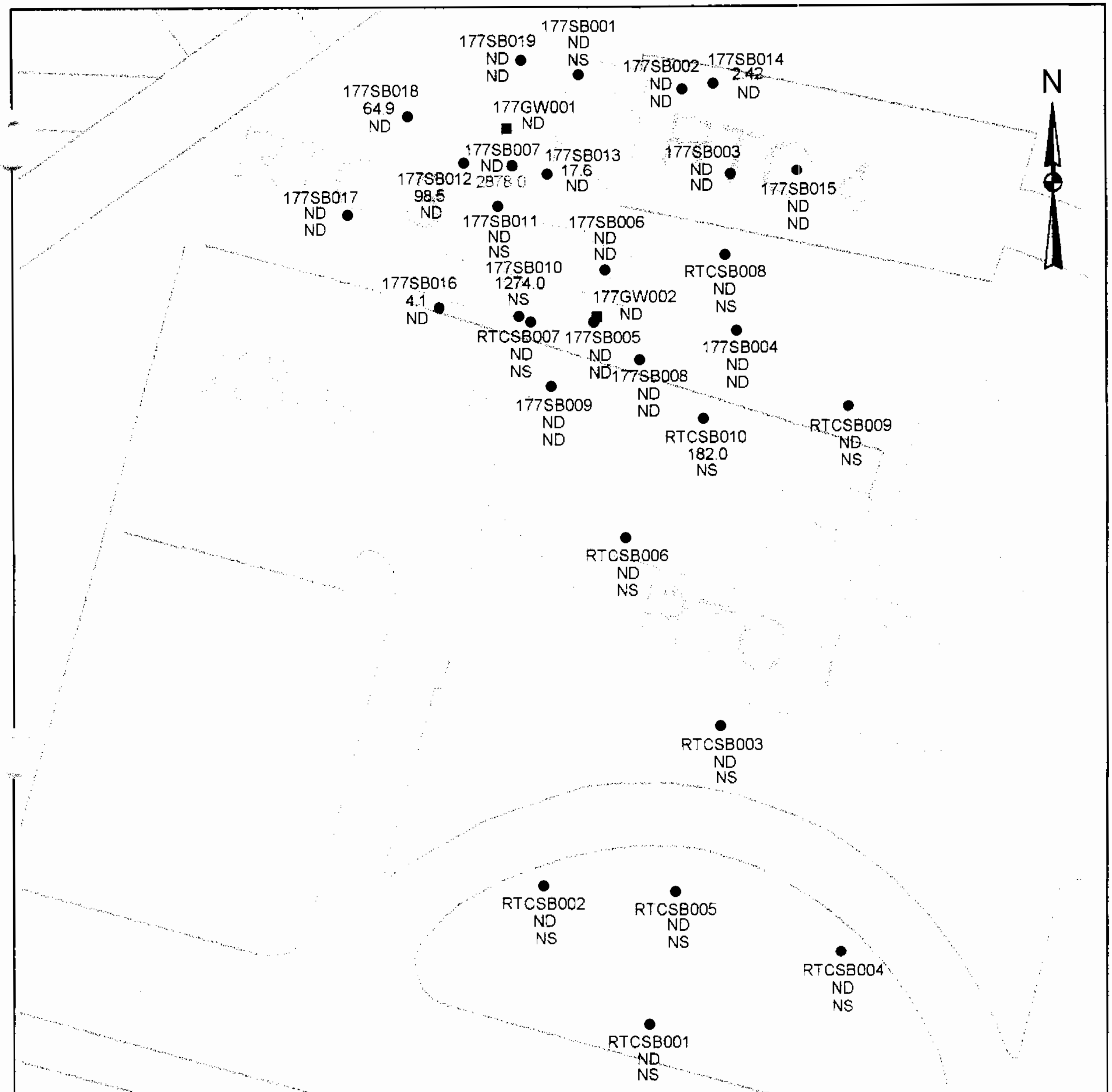
SCALE

20 0 20 40 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.12.3
ZONE I
177/RTC
1,1,2,2-TETRACHLOROETHANE
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=NA RBC=3200 UG/KG SSL=1.5 UG/KG



LEGEND

■	MONITORING WELL LOCATION
●	ZONE I SOIL BORING LOCATION
12.30	ZONE I SURFACE SOIL CONC. (UG/KG)
12.30	ZONE I SUBSURFACE SOIL CONC. (UG/KG)
12.30	MAXIMUM QUARTERLY GW CONC. (UG/L)
NS	NO SAMPLE TAKEN
ND	NON DETECT

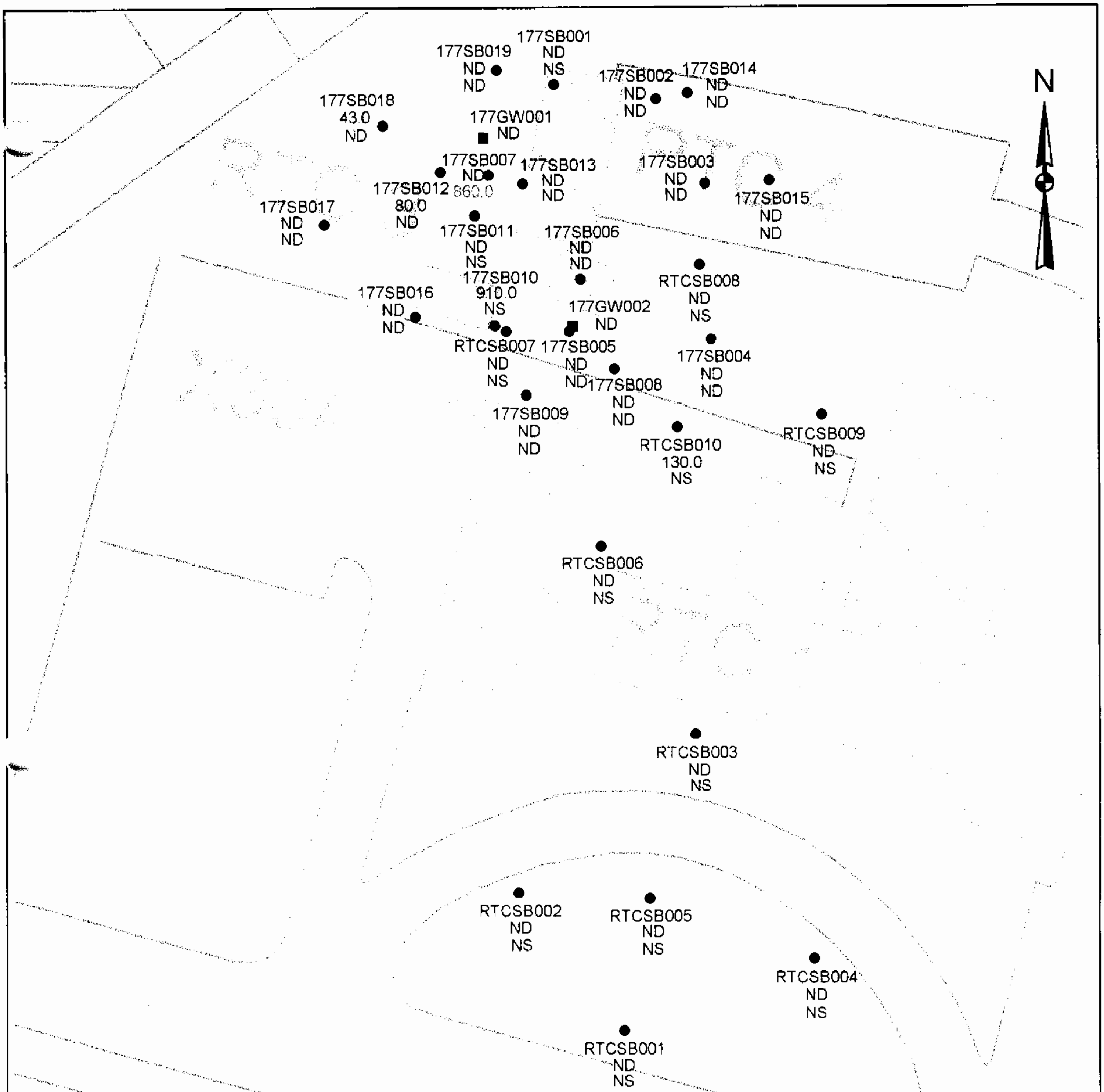
SCALE

20 0 20 40 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.12.4
ZONE I
177/RTC
BEQs
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=.2 UG/L RBC=87 UG/KG SSL=1600 UG/KG



LEGEND

■	MONITORING WELL LOCATION
●	ZONE I SOIL BORING LOCATION
12.30	ZONE I SURFACE SOIL CONC. (UG/KG)
12.30	ZONE I SUBSURFACE SOIL CONC. (UG/KG)
12.30	MAXIMUM QUARTERLY GW CONC. (UG/L)
NS	NO SAMPLE TAKEN
ND	NON DETECT

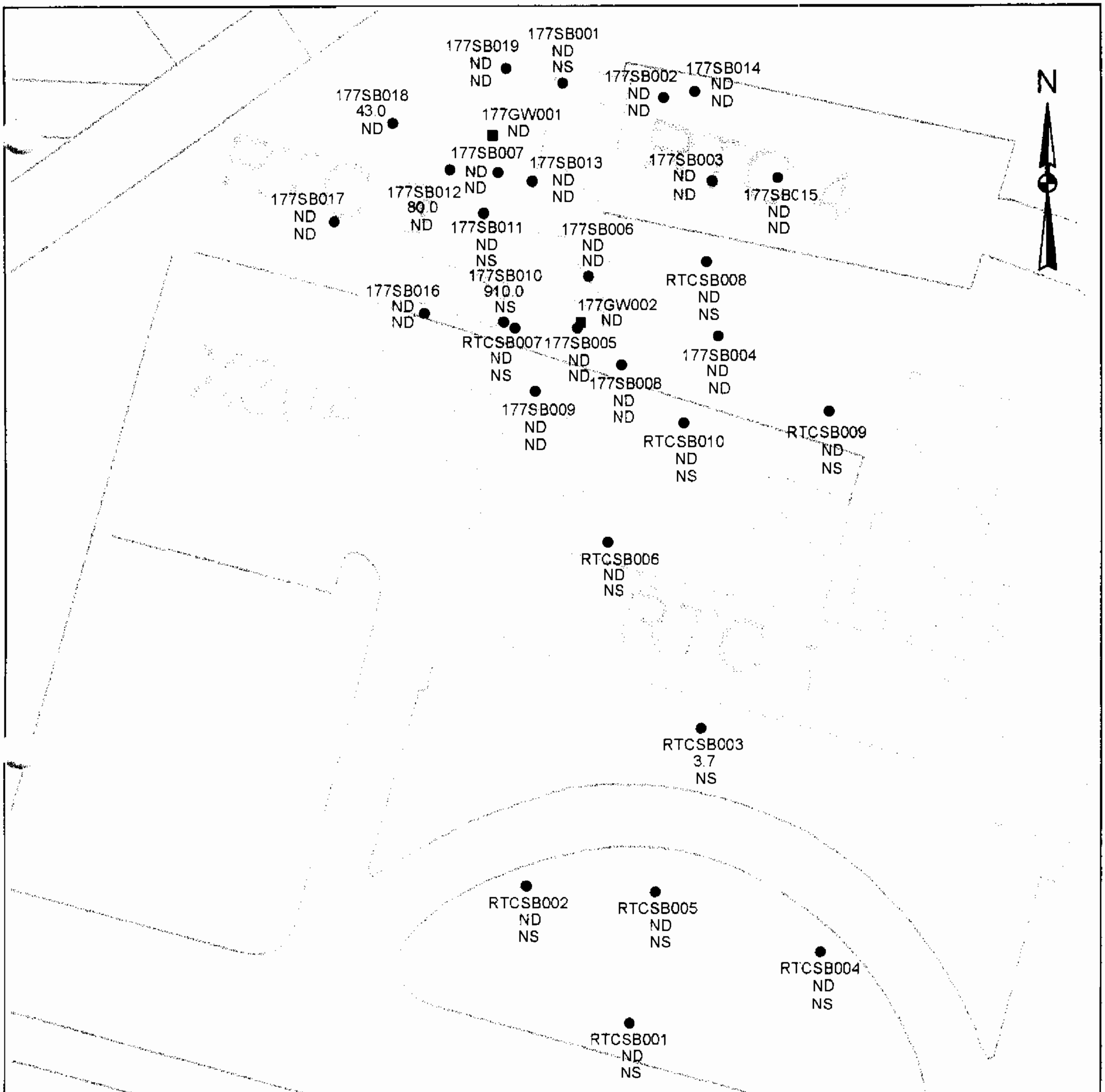
SCALE

20 0 20 40 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.12.5
ZONE I
177/RTC
BENZO(A)ANTHRACENE
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=NA RBC=870 UG/KG SSL=800 UG/KG



LEGEND

■	MONITORING WELL LOCATION
●	ZONE I SOIL BORING LOCATION
12.30	ZONE I SURFACE SOIL CONC. (UG/KG)
12.30	ZONE I SUBSURFACE SOIL CONC. (UG/KG)
12.30	MAXIMUM QUARTERLY GW CONC. (UG/L)
NS	NO SAMPLE TAKEN
ND	NON DETECT

SCALE

20 0 20 40 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.12.6
ZONE I
177/RTC
DIELDRIN
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=NA RBC=40 UG/KG SSL=2 UG/KG

The presence of volatiles and semivolatiles is entirely consistent with the past site activities. However, the limited frequency of SSL exceedances suggests that contamination is certainly not widespread. In summary, organic exceedances in soil validate the soil-to-groundwater pathway, but the limited occurrence above action levels and their absence in groundwater suggests that the pathway is not significant for organics.

10.12.5.2 Groundwater Migration

No constituents in site groundwater exceeded an RBC (human receptor pathway) or a surface water screening value; thus, these pathways are considered invalid for this SWMU and RTC area.

10.12.5.3 Soil-to-Air Transport

While 12 VOCs were detected in surface soil, all concentrations were far below their soil-to-air SSL. Therefore, the pathway is not considered valid at this site.

10.12.5.4 Fate and Transport Summary

Soil-to-Groundwater Pathway

Organics

Five organics are present in surface and subsurface soil at levels exceeding SSLs: methylene chloride, 1,1,2,2 tetrachloroethane, bezo(a)pyrene equivalents (BEQs), benzo(a)anthracene, and dieldrin.

None was widespread at high concentrations. Thus, the pathway is considerd valid, but it is not expected to be significant for organics.

Inorganics

No inorganics in site soil exceeded SSLs.

Groundwater Migration Pathway

No constituents exceeded RBCs or surface water screening values; thus, the groundwater pathway is considered invalid.

Soil-to-Air Pathway

Twelve VOCs were detected in surface soil, but none exceeded the soil-to-air SSL, thus invalidating this pathway.

10.12.6 Human Health Risk Assessment

10.12.6.1 Site Background and Investigative Approach

SWMU177/RTC was investigated to assess soil potentially affected by past site activities. The SWMU 177/RTC was not addressed in the *Final Zone I RFI Work Plan* (E/A&H, February 1995). This site was determined by USEPA Region IV to warrant limited investigation in conjunction with current construction activities. SWMU 177/RTC consisted of two adjacent buildings, both designated as Building RTC-4. The original RTC-4 was a 24 x 60 foot metal structure used to house heavy equipment including backhoes and trackhoes. The designation RTC-4 was given to a newer building constructed next to the former RTC-4. The newer RTC-4 was used to store lawn mowers and other lawn maintenance equipment. This unit was designated as a SWMU due to oil spillage associated with operations at the two buildings. Visual inspections during the RFA identified several areas of stained soil and concrete in and around the two buildings. These buildings were both less than 50 feet from the Cooper River. SWMU 177 originally consisted of Building RTC-4, which was used to store heavy equipment, such as backhoes and track hoes, as well as lawn maintenance equipment.

The assessment of SWMU 177 resulted from oil spills that were reported to have occurred in the area.

A limited investigation was performed at the RTC in conjunction with excavation and removal of asphalt, digging of foundations, etc., for the addition of a building wing for NOAA which had recently leased the site. The investigation was limited to upper-interval soil right next to construction activities. The RTC investigation involved the collection of 10 soil samples from the upper-interval. No groundwater sampling was performed in conjunction with the RTC investigation. The SWMU 177 investigation involved the collection of 19 soil samples from the upper-interval and 16 soil samples from the lower-interval. Two monitoring wells were established for the SWMU 177. Sections 10.12.1 and 10.12.3 summarizes the sampling activities for the RTC and SWMU 177. For purposes of this risk assessment, the data from these two investigations have been combined.

10.12.6.2 COPC Identification

Soil

Based on the screening comparisons described in Section 7 of this RFI and presented in Table 10.12.11, benzo(a)pyrene equivalents were identified as COPCs. No COPCs were screened out on the basis of background concentration alone.

Groundwater

Based on the screening comparisons described in Section 7 of this RFI and presented in Table 10.12.12, no COPCs were identified. Both arsenic and manganese exceeded their respective RBCs and were screened out on the basis of background concentration alone. No Wilcoxon rank sum test analysis was performed since there were only two samples collected and analyzed for inorganics

Table 10.12.11
Chemicals Present in Site Samples
SWMU 177/RTC - Surface Soil
Charleston Naval Complex
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration Residential RBC	Background	Units	Number Exceeding RBC	Background
Carcinogenic PAHs													
Benzo(a)pyrene Equivalents	*	7	29	2.42	1274	235	274	4160	87	NA	µG/KG	3	
Benzo(a)anthracene	*	4	29	43	910	291	340	3600	870	NA	µG/KG	1	
Benzo(a)pyrene	*	5	29	15	1000	257	340	3600	87	NA	µG/KG	2	
Benzo(b)fluoranthene	*	7	29	24	1000	210	340	3600	870	NA	µG/KG	1	
Benzo(k)fluoranthene		4	29	48	1100	357	340	3600	8700	NA	µG/KG		
Chrysene		6	29	17	1000	222	340	3600	87000	NA	µG/KG		
Indeno(1,2,3-cd)pyrene		3	29	52	710	273	340	3600	870	NA	µG/KG		
Inorganics													
Aluminum (Al)		17	17	990	5930	2870	NA	NA	7800	27400	MG/KG		
Arsenic (As)		16	17	0.61	5.2	2.50	0.35	0.35	0.43	21.6	MG/KG	16	
Barium (Ba)		17	17	5.3	20.6	10.4	NA	NA	550	54.2	MG/KG		
Beryllium (Be)		7	17	0.16	0.34	0.25	0.12	0.26	16	0.95	MG/KG		
Cadmium (Cd)		5	17	0.26	0.44	0.36	0.03	0.11	7.8	0.61	MG/KG		
Calcium (Ca)	N	17	17	766	248000	46251	NA	NA	NA	NA	MG/KG		
Chromium (Cr)		17	17	3.3	12.3	6.95	NA	NA	39	34.5	MG/KG		
Cobalt (Co)		17	17	0.49	3	1.20	NA	NA	470	5.8	MG/KG		
Copper (Cu)		17	17	1.1	112	9.80	NA	NA	310	240	MG/KG		
Cyanide		2	16	0.22	0.24	0.23	0.21	0.6	160	NA	MG/KG		
Iron (Fe)	N	17	17	1490	5560	3491	NA	NA	NA	NA	MG/KG		
Lead (Pb)		17	17	2.5	83.6	14.0	NA	NA	400	203	MG/KG		
Magnesium (Mg)	N	17	17	171	2770	709	NA	NA	NA	NA	MG/KG		
Manganese (Mn)		17	17	10.2	118	40.7	NA	NA	160	419	MG/KG		
Mercury (Hg)		1	17	0.26	0.26	0.26	0.03	0.12	2.3	0.47	MG/KG		
Nickel (Ni)		17	17	0.99	7.6	2.51	NA	NA	160	23.9	MG/KG		
Potassium (K)	N	15	17	168	621	271	157	171	NA	NA	MG/KG		
Selenium (Se)		3	17	0.56	0.78	0.65	0.48	0.57	39	1.49	MG/KG		
Sodium (Na)	N	7	17	66.3	296	194	106	161	NA	NA	MG/KG		
Tin (Sn)		1	17	2.4	2.4	2.4	0.66	2.3	4700	7.5	MG/KG		
Vanadium (V)		17	17	3.1	13.7	7.61	NA	NA	55	113	MG/KG		
Zinc (Zn)		17	17	5.1	137	28.2	NA	NA	2300	206	MG/KG		

Table 10.12.11
Chemicals Present in Site Samples
SWMU 177/RTC - Surface Soil
Charleston Naval Complex
Charleston, South Carolina

Parameter	Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration Residential RBC	Screening Concentration Background	Units	Number Exceeding RBC	Number Exceeding Background
Pesticides/PCBs												
4,4'-DDD	7	17	0.22	6.8	3.30	1.9	2.8	2700	NA	µG/KG		
4,4'-DDE	10	17	3.8	75.5	32.0	1.9	2.7	1900	NA	µG/KG		
4,4'-DDT	11	17	0.085	38	12.3	1.9	2.7	1900	NA	µG/KG		
Aroclor-1260	2	17	33	190	112	8.3	76	320	NA	µG/KG		
alpha-Chlordane	1	7	4.25	4.25	4.25	1.3	1.5	1800	NA	µG/KG		
gamma-Chlordane	1	7	6.95	6.95	6.95	1.3	1.5	1800	NA	µG/KG		
Chlordane	4	10	40	680	227	1.65	2.3	1800	NA	µG/KG		
delta-BHC	1	17	0.9	0.9	0.9	0.51	1.5	350	NA	µG/KG		
Dieldrin	1	17	3.7	3.7	3.7	0.63	2.8	40	NA	µG/KG		
Endosulfan II	1	17	0.045	0.045	0.045	1.37	2.8	47000	NA	µG/KG		
Endrin	3	17	2.2	5.1	3.37	1.05	2.8	2300	NA	µG/KG		
Endrin aldehyde	1	17	5.2	5.2	5.2	0.42	2.8	2300	NA	µG/KG		
Heptachlor epoxide	3	17	0.57	3.05	2.17	0.42	1.5	70	NA	µG/KG		
Methoxychlor	1	17	2	2	2	1.8	15	39000	NA	µG/KG		
Semivolatile Organics												
Acenaphthene	2	29	57	98	77.5	340	3600	470000	NA	µG/KG		
Anthracene	2	29	37	170	88.5	340	3600	2300000	NA	µG/KG		
Benzo(g,h,i)perylene	3	29	53	650	252	340	3600	310000	NA	µG/KG		
Benzoic acid	2	29	220	1200	710	1700	18000	31000000	NA	µG/KG		
bis(2-Ethylhexyl)phthalate (BEHP)	8	29	45	770	208	340	3600	46000	NA	µG/KG		
Butylbenzylphthalate	2	29	33	79	56	340	3600	1600000	NA	µG/KG		
Di-n-butylphthalate	8	29	39	97	68.4	340	3600	780000	NA	µG/KG		
Fluoranthene	7	29	26	1400	287	340	3600	310000	NA	µG/KG		
Phenanthrene	3	29	80	790	343	340	3600	230000	NA	µG/KG		
Pyrene	7	29	18	1700	310	340	3600	230000	NA	µG/KG		
Volatile Organics												
Acetone	7	29	8	160	62.9	5	100	780000	NA	µG/KG		
Benzene	1	29	0.84	0.84	0.84	5	17	22000	NA	µG/KG		
2-Butanone	1	29	3	3	3	5	40	4700000	NA	µG/KG		
1,1-Dichloroethene	1	29	2	2	2	5	23	1100	NA	µG/KG		
1,2-Dichloroethene (total)	1	29	6	6	6	5	52	70000	NA	µG/KG		

Table 10.12.11
Chemicals Present in Site Samples
SWMU 177/RTC - Surface Soil
Charleston Naval Complex
Charleston, South Carolina

Parameter	Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration Residential RBC	Background	Units	Number Exceeding RBC	Background
Ethylbenzene	5	29	0.64	1.8	1.15	5	17	780000	NA	µG/KG		
2-Hexanone	1	29	6	6	6	5	40	312800	NA	µG/KG		
4-Methyl-2-Pentanone (MIBK)	1	29	6	6	6	5	29	630000	NA	µG/KG		
Methylene chloride	2	29	7	12	9.5	5	24	85000	NA	µG/KG		
1,1,2,2-Tetrachloroethane	1	29	2	2	2	5	11	3200	NA	µG/KG		
Toluene	3	29	0.77	1.9	1.16	5	17	1600000	NA	µG/KG		
Trichloroethene	4	29	2	3	2.5	5	23	58000	NA	µG/KG		
Xylene (Total)	5	29	4.3	7.9	5.82	5	23	16000000	NA	µG/KG		
TPH												
Diesel	1	7	39.6	39.6	39.6	2.09	2.28	NA	NA	µG/KG		
Gasoline	1	7	21.2	21.2	21.2	10.9	11.4	NA	NA	µG/KG		
TCDD Equivalents												
Dioxin (TCDD Equivalents)	9	9	0.03	1.67	0.43	NA	NA	4.3	NA	NG/KG		

Notes:
* - Indicates chemical was identified as a COPC
N - Indicates chemical is an essential nutrient
SQL - Sample quantitation limit
RBC - Risk-based concentration
µG/KG - micrograms per kilogram
MG/KG - milligrams per kilogram
NG/KG - nanograms per kilogram
NA - Not applicable or not available
ND - Not determined due to lack of information

Table 10.12.12
Chemicals Present in Site Samples
SWMU 177/RTC - Shallow Groundwater
Charleston Naval Complex
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration Tap Water RBC	Background	Units	Number Exceeding RBC	Background
Inorganics													
Arsenic (As)		2	2	1.5	2.1	1.8	NA	NA	0.045	23	μG/L	2	
Calcium (Ca)	N	2	2	67100	105000	86050	NA	NA	NA	NA	μG/L		
Iron (Fe)	N	1	2	5580	5580	5580	115	115	NA	NA	μG/L		
Magnesium (Mg)	N	2	2	8130	25600	16865	NA	NA	NA	NA	μG/L		
Manganese (Mn)		2	2	44.4	270	157	NA	NA	73	5430	μG/L	1	
Potassium (K)	N	2	2	7680	19200	13440	NA	NA	NA	NA	μG/L		
Sodium (Na)	N	1	2	132000	132000	132000	24000	24000	NA	NA	μG/L		
Semivolatile Organics													
Acenaphthene		2	4	1	1.9	1.45	6	10	220	NA	μG/L		
Volatile Organics													
Carbon disulfide		1	4	0.52	0.52	0.52	1	3	100	NA	μG/L		

Notes:
* - Indicates chemical was identified as a COPC
N - Indicates chemical is an essential nutrient
SQL - Sample quantitation limit
RBC - Risk-based concentration
μG/L - micrograms per liter
PG/L - picograms per liter
NA - Not applicable or not available
ND - Not determined due to lack of information

10.12.6.3 Exposure Assessment

Exposure Setting

The RTC is currently under development to house offices of NOAA. It is in close proximity to SWMU 177 which was designated for further investigation in RFAs issued after approval of the Zone I RFI Work Plan. SWMU 177 consisted of two buildings used to house heavy equipment, store oils, fuels and lawn care equipment.

Potentially Exposed Populations

Potentially exposed populations are current and future site workers. Additional potentially exposed populations are hypothetical future site residents. Future site resident and worker exposure scenarios were addressed in this risk assessment. The hypothetical future site worker scenario assumed continuous exposure to surface soil conditions. Current site workers' exposure would be less than that assumed for the hypothetical future site worker scenario because of their limited soil contact and the fact that groundwater is not currently used onsite. Therefore, future worker assessment is considered to be protective of current site users.

Exposure Pathways

Exposure pathways for the future site workers are dermal contact and incidental ingestion of surface soils. The exposure pathways for future residential land use are the same as those for the future site worker. In addition, the hypothetical future site worker scenario assumed continuous exposure to surface soil conditions. Uniform exposure was assumed for all sample locations. Table 10.12.13 presents the justification for exposure pathways assessed in this HHRA.

Exposure Point Concentrations

As discussed in Section 7 of this RFI, 95% UCLs were calculated for datasets consisting of at least 10 samples. As shown in Table 10.12.14, the 95% UCL for benzo(a)pyrene equivalents was used as the EPC to quantify exposure.

Table 10.12.13
SWMU 177/RTC
Exposure Pathways Summary

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Current Land Uses			
Current Users (Site Workers)	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	This exposure pathway was considered insignificant compared to the other pathways.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Shallow groundwater is not currently used as a source of potable or non-residential water at SWMU 177/RTC.
	Shallow groundwater, Inhalation of volatilized shallow groundwater contaminants	No	Shallow groundwater is not currently used as a source of potable or non-residential water at SWMU 177/RTC.
	Soil, Incidental ingestion	No (Qualified)	Future site use is considered conservatively representative of current site use.
	Soil, Dermal contact	No (Qualified)	Future site use is considered conservatively representative of current site use.
Future Land Uses			
Future Site Residents (Child and Adult), Future Site Worker	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	This exposure pathway was considered insignificant compared to the other pathways.
	Shallow groundwater, ingestion of contaminants during potable or general use	No	No COPCs were identified for SWMU 177/RTC groundwater.
	Shallow groundwater, Inhalation of volatilized contaminants during domestic use	No	No COPCs were identified for SWMU 177/RTC groundwater.
	Soil, Incidental ingestion	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.
	Soil, Dermal contact	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.
	Wild game or domestic animals, Ingestion of tissue impacted by media contamination	No	Hunting/taking of game and/or raising livestock is prohibited within the Charleston, South Carolina, city limits.
	Fruits and vegetables, Ingestion of plant tissues grown in media	No	The potential for significant exposure via this pathway is low relative to that of other exposure pathways assessed.

Table 10.12.14
Statistical Analysis of COPCs
Surface Soils at SWMU 177/RTC
Charleston Naval Complex
Charleston, South Carolina

COPC	n	Natural Log-Transformed mean	SD	H-stat	UCL (mg/kg)	MAX (mg/kg)	EPC (mg/kg)	
Benzo(a)pyrene Equivalents	29	-0.584	0.602	2.027	0.8	1.274	0.8	UCL

Notes:
mean Arithmetic mean of the log-transformed data
n Number of samples analyzed
SD Standard deviation for a sample of data
H-stat "H" statistic from Gilbert 1987; cuboidal interpolation was used to determine the value i accordance with USEPA *Supplemental Guidance to RAGS, Calculating the Concentration Term.*
NA Not applicable
EPC Exposure point concentration
UCL 95 percentile upper confidence level mean
MAX maximum reported concentration

Quantification of Exposure

CDIs for ingestion and dermal contact with soils are shown in Tables 10.12.15 and 10.12.16, respectively.

10.12.6.4 Toxicity Assessment

Toxicity assessment terms and methods are discussed in Section 7 of this report. Table 10.12.17 presents toxicological information specific to each COPC identified at SWMU 177/RTC. This information was used in the quantification of risk/hazard associated with soil and groundwater contaminants. Brief toxicological profiles for each COPC are provided in the following paragraphs.

Benzo(a)pyrene equivalents include the following polynuclear aromatic hydrocarbons (PAHs):

Benzo(a)anthracene	TEF 0.1
Benzo(a)pyrene	TEF 1.0
Benzo(b)fluoranthene	TEF 0.1
Benzo(k)fluoranthene	TEF 0.01
Chrysene	TEF 0.001
Dibenz(a,h)anthracene	TEF 1.0
Indeno(1,2,3-cd)pyrene	TEF 0.1

Some PAHs are toxic to the liver, kidney, and blood. However, the toxic effects of those PAHs have not been well established. There are no RfDs for them due to a lack of data. All PAHs listed above are classified by USEPA as B2 carcinogens, and their carcinogenicity is addressed relative to that of benzo(a)pyrene, which has an oral SF of 7.3 $(mg/kg\text{-}day)^{-1}$. TEFs, also set by USEPA, are multipliers applied to the detected concentrations, which are subsequently used to

Table 10.12.15
Chronic Daily Intakes
Incidental Ingestion of Surface Soil
SWMU 177/RTC
Charleston Naval Complex
Charleston, South Carolina

Chemical	Fraction Ingested from Contaminated Source *	Exposure Point Concentration (mg/kg)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident lwa C-CDI (mg/kg-day)	Future Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Benzo(a)pyrene Equivalents	1	0.8	1.15E-06	1.08E-05	1.32E-06	4.12E-07	1.47E-07

Notes:
LWA Lifetime-weighted average; used to calculate carcinogenic CDI, RAGS Parts A and B.
CDI Chronic daily intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
* Reflects the estimated fraction of the site impacted by the corresponding COPC
mg/kg Milligrams per kilgram
mg/kg-day Milligrams per kilgram per day

Table 10.12.16
Chronic Daily Intakes
Dermal Contact with Surface Soil
SWMU 177/RTC
Charleston Naval Complex
Charleston, South Carolina

Chemical	Exposure Point Concentration (mg/kg)	Fraction Contacted from Contaminated Source *	Dermal Absorption Factor+ (unitless)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident LWA C-CDI (mg/kg-day)	Future Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Benzo(a)pyrene Equivalent	0.8	1	0.01	4.73E-07	1.56E-06	2.96E-07	3.38E-07	1.21E-07

Notes:
CDI Chronic daily intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
\+ The dermal absorption factor was applied to the exposure point concentration to reflect the different transdermal migration of inorganic versus organic chemicals.
* Reflects the estimated fraction of the site impacted by the corresponding COPC.
mg/kg Millograms per kilogram
mg/kg-day Millograms per kilogram per day
LWA Lifetime-weighted average

Table 10.12.17
Toxicological Reference Information
for Chemicals of Potential Concern
SWMU 177/RTC
Charleston Naval Complex
Charleston, South Carolina

Chemical	*Non-Carcinogenic Toxicity Data*								*Carcinogenic Toxicity Data*			
	Oral Reference Dose (mg/kg-day)	Confidence Level	Critical Effect	Uncertainty Factor Oral	Inhalation Reference Dose (mg/kg-day)	Confidence Level	Critical Effect	Uncertainty Factor Inhalation	Oral Slope Factor (kg-day/mg)	Inhalation Slope Factor (kg-day/mg)	Weight of Evidence	Tumor Type
Benzo(a)pyrene Equivalents	NA	NA	NA	NA	NA	NA	NA	NA	7.3 a	3.1 b	B2	mutagen

Notes:
a = Integrated Risk Information System (IRIS)
b = Withdrawn from IRIS/HEAST
NA = Not applicable or not available

calculate excess cancer risk. These multipliers are discussed further in the exposure and toxicity assessment sections. Most carcinogenic PAHs have been classified as such due to animal studies using large doses of purified PAHs. There is some doubt as to the validity of these listings, and the SFs listed in USEPA's RBC table are provisional. However, these PAHs are carcinogens when the exposure involves a mixture of other carcinogenic substances (e.g., coal tar, soot, cigarette smoke). As listed in IRIS, human data specifically linking benzo(a)pyrene to a carcinogenic effect are lacking. There are, however, multiple animal studies in many species demonstrating benzo(a)pyrene to be carcinogenic by numerous routes.

Benzo(a)pyrene has produced positive results in numerous genotoxicity assays. At the June 1992 CRAVE Work Group meeting, a revised risk estimate of benzo(a)pyrene was verified. This section provides information on the aspects of the carcinogenic risk assessment for the agent in question: the USEPA classification and quantitative estimates of exposure. The classification reflects a weight-of-evidence judgment of the likelihood that the agent is a human carcinogen. The quantitative risk estimates are presented in application of a low-dose extrapolation procedure and presented as the risk per mg/kg-day. The unit risk is the quantitative estimate in terms of either risk per μg/L drinking water or risk per $\mu g/m^3$ air breathed. The third form in which risk is presented is drinking water or air concentration providing cancer risks of 1 in 10,000 or 1 in 1,000,000. The carcinogenicity background document provides details on the carcinogenicity values found in IRIS. Users are referred to the Oral Reference Dose and Reference Concentration sections for information on long-term toxic effects other than carcinogenicity.

As listed in IRIS, the basis for the dibenz(a,h)anthracene and benzo(b)fluoranthene B2 classification is no human data and sufficient data from animal bioassays. Benzo(b)fluoranthene produced tumors in mice after lung implantation, intraperitoneal or subcutaneous injection, and skin painting. As listed in IRIS, the basis for the benzo(a)anthracene B2 classification is no human data and sufficient data from animal bioassays. Benzo(a)anthracene produced tumors in mice exposed by gavage; intraperitoneal, subcutaneous or intramuscular injection; and topical application. Benzo(a)anthracene produced mutations in bacteria and in mammalian cells, and transformed mammalian cells in culture. As listed in IRIS, the basis for the benzo(k)fluoranthene B2 classification is no human data and sufficient data from animal bioassays. Benzo(k)fluoranthene produced tumors after lung implantation in mice and when administered with a promoting agent in skin-painting studies. Equivocal results have been found in a lung adenoma assay in mice. Benzo(k)fluoranthene is mutagenic in bacteria. (Klaasen, et al., 1986).

10.12.6.5 Risk Characterization

Surface Soil Pathways

Exposure to surface soil onsite was evaluated under both future residential and industrial (site worker) scenarios. For these scenarios, the incidental ingestion and dermal contact exposure pathways were evaluated. For noncarcinogenic contaminants evaluated for future site residents, hazard was computed separately to address child and adult exposure. Tables 10.12.18 and 10.12.19 present the computed carcinogenic risks and/or HQs associated with the incidental ingestion of and dermal contact with site surface soils, respectively.

Hypothetical Site Residents

The ingestion ILCR (based on the adult and child lifetime-weighted average) for combined SWMU 177 surface soils is 1E-05, and the dermal pathway ILCR is 4E-06. Benzo(a)pyrene equivalents were the primary contributor to ILCR for both pathways.

Future Site Workers

Site worker ILCRs are 1E-06 and 2E-06 for the ingestion and dermal contact pathways, respectively. Benzo(a)pyrene equivalents were the primary contributors to ILCR for both pathways.

Table 10.12.18
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
SWMU 177/RTC
Charleston Naval Complex
Charleston, South Carolina

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used $(mg/kg\text{-}day)^{-1}$	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident LWA ILCR	Future Worker adult Hazard Quotient	Future Worker adult ILCR
Benzo(a)pyrene Equivalents	NA	7.3	ND	ND	9.6E-06	ND	1.1E-06
SUM Hazard Index/ILCR			ND	ND	1E-05	ND	1E-06

Notes:
NA Not available
ND Not determined due to lack of available information
lwa Lifetime-weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A.
ILCR Incremental lifetime excess cancer risk

Table 10.12.19
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
SWMU 177/RTC
Charleston Naval Complex
Charleston, South Carolina

Chemical	Dermal Adjustment	Oral RfD Used (mg/kg-day)	Oral SF Used $(mg/kg\text{-}day)^{-1}$	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident LWA ILCR	Future Worker adult Hazard Quotient	Future Worker adult ILCR
Benzo(a)pyrene Equivalents	0.5	NA	14.6	ND	ND	4.3E-06	ND	1.8E-06
SUM Hazard Index/ILCR				ND	ND	4E-06	ND	2E-06

Notes:
- NA Not available
- ND Not determined due to lack of available information
- ILWA Lifetime-weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A.
- ILCR Incremental Lifetime excess Cancer Risk
- \- Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency, which should not be applied to dermal exposure and dermal CDI).
- mg/kg-day Milligram per kilogram per day

The RTC area was covered by an asphalt parking lot at the time of sampling. Current site users engaged in construction activities have an enhanced chance of exposure to affected surface soil. Because the formal site worker assessment assumed uniform exposure to surface soil, the risk/hazard projections are loosely applicable to construction workers. It should be recognized that site construction activities generally last no more than two years (or approximately one-fifteenth of the exposure duration assumed for chronic exposure). Construction activities do, however, result in greater incidental ingestion and dermal contact with surface soil than normal occupational site activities. The typical construction worker incidental soil ingestion rate will approximately 500 mg/day (or 10 times more than the standard worker assumption). When the increased opportunity for soil ingestion is factored with the limited duration of exposure, the chronic exposure based on risk/hazard projections provides a conservative estimate of the threat to construction workers.

If previous asphalt surface is restored (or a building is constructed in its place), potential exposure to affected surface soil will be minimized.

COCs Identified

USEPA has established a generally acceptable risk range of 1E-4 to 1E-6, and a hazard index threshold of 1.0 (unity). In this HHRA, a COC was considered to be any chemical contributing to a cumulative risk level of 1E-6 or greater and/or a cumulative hazard index above 1.0 if its individual ILCR exceeds 1E-6 or its hazard quotient exceeds 0.1. For carcinogens, this approach is relatively conservative because a cumulative risk level of 1E-4 (and individual ILCR of 1E-6) is recommended by USEPA Region IV as the trigger for establishing COCs. The COC selection algorithm presented was used to more comprehensively evaluate chemicals contributing to carcinogenic risk or noncarcinogenic hazard during the remedial goal option development. Table 10.12.20 summarizes the COCs identified for SWMU 177/RTC.

Table 10.12.20
Summary of Risk and Hazard-based COCs
SWMU 177/RTC
Charleston Naval Complex
Charleston, South Carolina

Medium	Exposure Pathway		Future Resident Adult Hazard Quotient	Future Resident Child Hazard Quotient	Future Resident LWA ILCR	Current Site Worker Hazard Quotient	Current Site Worker ILCR	Identification of COCs	
Surface Soil	Incidental Ingestion	Benzo(a)pyrene Equivalents	ND	ND	9.6E-06	ND	1.1E-06	2	4
	Dermal	Benzo(a)pyrene Equivalents	ND	ND	4.3E-06	ND	1.8E-06	2	4
Surface Soil Pathway Sum			ND	ND	1E-05	ND	3E-06		
Sum of All Pathways			ND	ND	1E-05	ND	3E-06		

Notes:
ND = Not determined due to the lack of available risk information.
ILCR = Incremental excess lifetime cancer risk
LWA = Lifetime-weighted average
1- Chemical is a COC by virtue of projected child resident noncarcinogenic hazard.
2- Chemical is a COC by virtue of projected future resident lifetime ILCR.
3- Chemical is a COC by virtue of projected site worker noncarcinogenic hazard.
4- Chemical is a COC by virtue of projected site worker ILCR.

Surface Soils

Hypothetical Site Residents (future land use)

Benzo(a)pyrene equivalents were identified as COCs for this scenario based on the sum ILCR.

10.12.6.6 Risk Uncertainty

Characterization of Exposure Setting and Identification of Exposure Pathways

The potential for high bias is introduced through the exposure setting and pathway selection due to the highly conservative assumptions (i.e., future residential use) recommended by USEPA Region IV when assessing potential future and current exposure. The exposure assumptions made in the future site worker scenario are highly protective and would tend to overestimate exposure.

Current site workers include construction employees who may be consistently exposed to surface soil. Site workers would not, however, be expected to work onsite in contact with affected media for eight hours per day, 250 days per year, as assumed in the exposure assessment. The COPCs identified in surface soil are limited in extent.

Residential use of the site would not be expected, based on current site uses and the nature of surrounding buildings. Current reuse plans call for continued commercial/industrial use of Zone I, and the RTC is currently being redeveloped for use by NOAA as administrative/office space. If this area were to be used as a residential site, the buildings would be demolished, asphalt surface removed, and the surface soil conditions would likely change — the soils could be covered with landscaping soil and/or a house. Consequently, exposure to current surface soil conditions would not be likely under a true future residential scenario. These factors indicate that exposure pathways assessed in this HHRA would generally overestimate the risk and hazard posed to current site workers and future site residents.

Determination of Exposure Point Concentrations

The 95%UCL was used as the EPC for evaluating soil pathway exposures to benzo(a)pyrene equivalents. Generally, use of the 95% UCL as the EPC results in an overestimation of risk estimates.

Frequency of Detection and Spatial Distribution

Benzo(a)pyrene equivalents were detected in seven of 29 surface soil samples collected at SWMU 177/RTC. In only three of these seven samples (177SB010, 177SB012, and RTCSB010) benzo(a)pyrene equivalents exceeded their residential RBC.

Quantification of Risk/Hazard

As indicated by the discussions above, the uncertainty inherent in the risk assessment process is great. In addition, many site-specific factors have affected the uncertainty of this assessment that would upwardly bias the risk and hazard estimates. Exposure pathway-specific sources of uncertainty are discussed below.

Of the CPSSs screened and eliminated from formal assessment, none was reported at a concentration within approximately 10% of the RBC. This minimizes the likelihood of potentially significant cumulative risk/hazard based on the eliminated CPSSs. Concentrations of arsenic exceeded its RBC, but not its reference concentrations. Therefore, arsenic was eliminated from formal assessment based on comparisons to reference concentrations.

Although the future land use at this site is unknown, both the future worker and residential exposure scenarios were assessed in this HHRA. As previously discussed, these scenarios would likely lead to overestimates of risk and/or hazard.

10.12.6.7 Risk Summary

The risk and hazard posed by contaminants at SWMU 177/RTC were assessed for the hypothetical future site worker and the hypothetical future site resident under reasonable maximum exposure assumptions. In surface soils, the incidental ingestion and dermal contact pathways were assessed in this HHRA. Table 10.12.21 summarizes risk for each pathway/receptor group evaluated for SWMU 177/RTC.

Soil — Residential Scenario

Benzo(a)pyrene equivalents were identified as residential soil pathway COCs for SWMU 177/RTC. Figure 10.12.7 provides the risk map for SWMU 177/RTC soil under a residential scenario. As shown, only four sample locations were associated with a risk estimate above 1E-06 (177SB010, 177SB012, 177SB018, and RTCSB010). Table 10.12.22 provides the point risk and hazard estimates for SWMU 177/RTC residential soil pathways.

Soil — Future Site Worker Scenario

Benzo(a)pyrene equivalents were identified as future site worker soil pathway COCs for SWMU 177/RTC. Figure 10.12.8 provides the risk map for SWMU 177/RTC soil under a future site worker scenario. As shown only one sample location was associated with a risk estimate above 1E-06 (177SB010). Table 10.12.23 provides the point risk and hazard estimates for the future site worker soil pathways.

Groundwater

No COCs were identified for groundwater based on the screening criteria provided in Section 7.

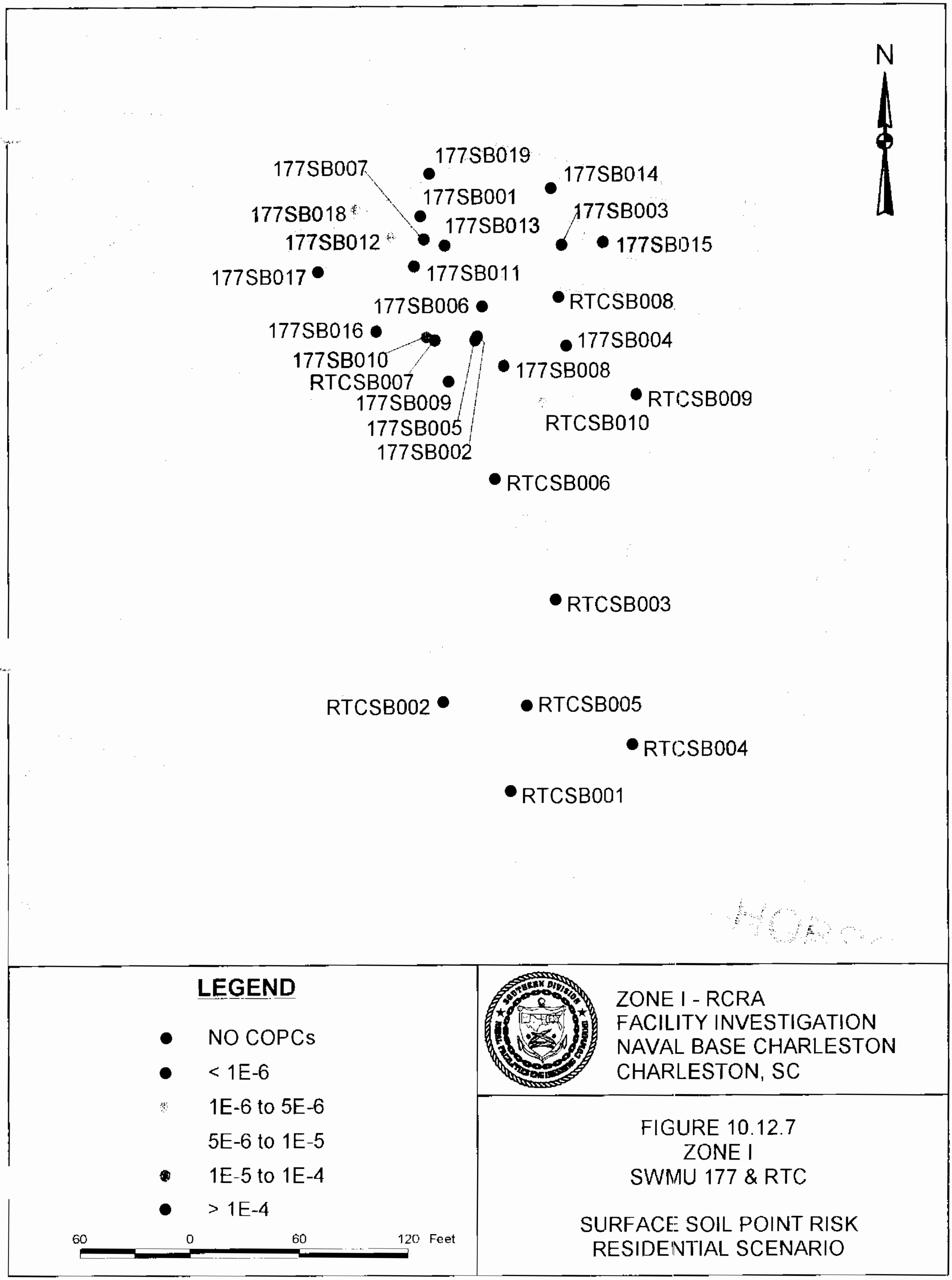
10.12.6.8 Remedial Goal Options

Table 10.12.24 provides the RGOs for the COCs identified for combined SWMU 177 soil.

Table 10.12.21
Summary of Risk and Hazard
SWMU 177/RTC
Charleston Naval Complex
Charleston, South Carolina

Medium	Exposure Pathway	HI (Adult)	HI (Child)	ILCR (LWA)	HI (Worker)	ILCR (Worker)
Surface Soil	Incidental Ingestion	ND	ND	1E-05	ND	1E-06
	Dermal Contact	ND	ND	4E-06	ND	2E-06
Sum of Surface Soil Pathways		ND	ND	1E-05	ND	3E-06
Sum of All Pathways		ND	ND	1E-05	ND	3E-06

Notes:
ND = Not determined due to the lack of available risk information.
ILCR = Incremental excess lifetime cancer risk
LWA = Lifetime-weighted average



ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.12.7
ZONE I
SWMU 177 & RTC

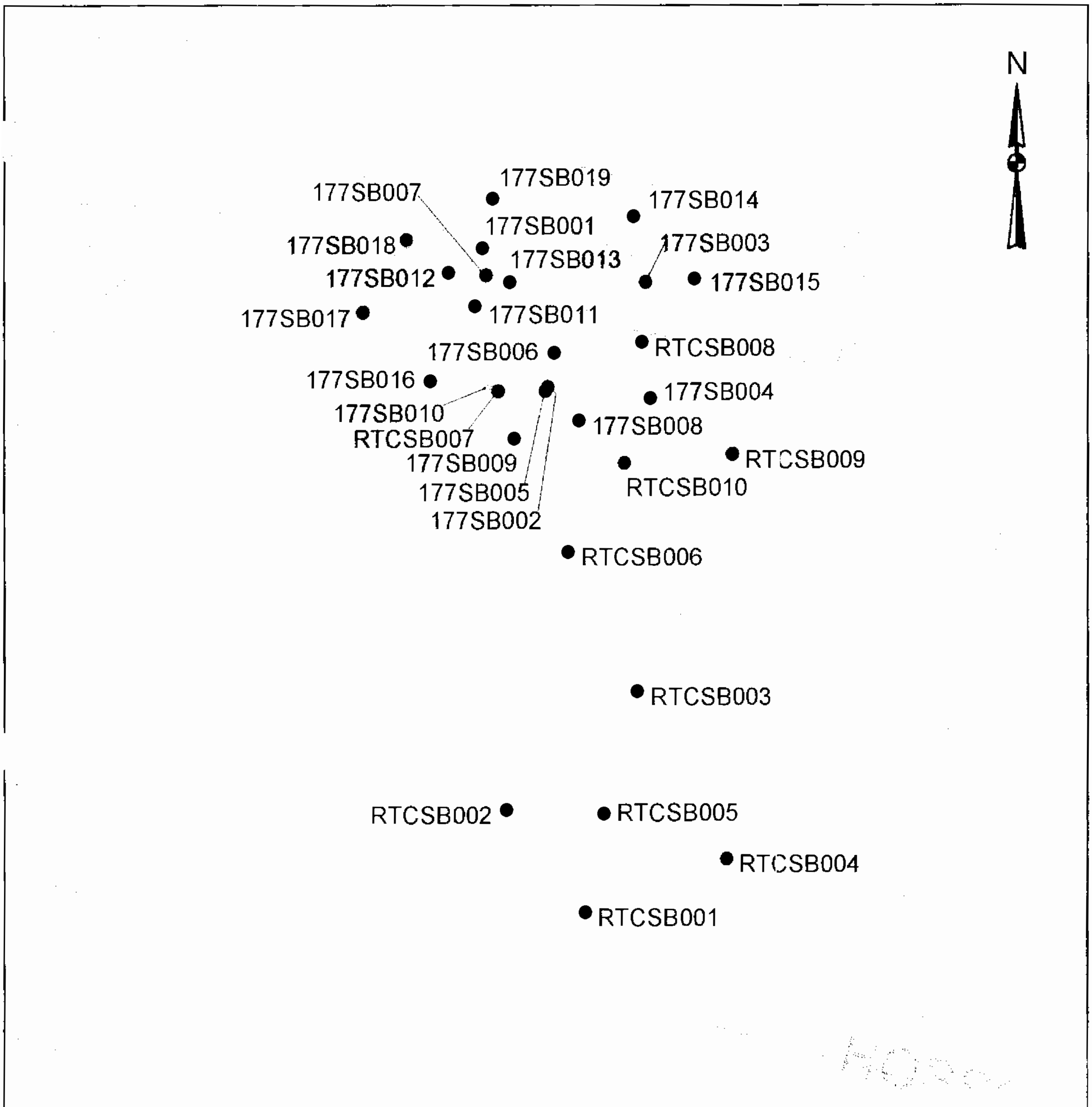
SURFACE SOIL POINT RISK
RESIDENTIAL SCENARIO

Table 10.12.22
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
SWMU 177/RTCenter - Zone I
Charleston Naval Complex
Charleston, South Carolina

SWMU	Location	Parameter	Concentration	Units	Hazard Index	Risk (E-06)
177	B001	No COPCs			NA	NA
177	B002	No COPCs			NA	NA
177	B003	No COPCs			NA	NA
177	B004	No COPCs			NA	NA
177	B005	No COPCs			NA	NA
177	B006	No COPCs			NA	NA
177	B007	No COPCs			NA	NA
177	B008	No COPCs			NA	NA
177	B009	No COPCs			NA	NA
177	B010	Benzo(a)pyrene equivalents	1274	µg/kg	NA	21.10
177	B011	No COPCs			NA	NA
177	B012	Benzo(a)pyrene equivalents	98.488	µg/kg	NA	1.63
177	B013	Benzo(a)pyrene equivalents	17.619	µg/kg	NA	0.29
177	B014	Benzo(a)pyrene equivalents	2.417	µg/kg	NA	0.04
177	B015	No COPCs			NA	NA
177	B016	Benzo(a)pyrene equivalents	4.1	µg/kg	NA	0.07
177	B018	No COPCs			NA	NA
177	B018	Benzo(a)pyrene equivalents	64.93	µg/kg	NA	1.08
RTC	B001	No COPCs			NA	NA
RTC	B002	No COPCs			NA	NA
RTC	B003	No COPCs			NA	NA
RTC	B004	No COPCs			NA	NA
RTC	B005	No COPCs			NA	NA
RTC	B006	No COPCs			NA	NA

Table 10.12.22
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
SWMU 177/RTCenter - Zone I
Charleston Naval Complex
Charleston, South Carolina

SWMU	Location	Parameter	Concentration	Units	Hazard Index	Risk (E-06)
RTC	B007	No COPCs			NA	NA
RTC	B008	No COPCs			NA	NA
RTC	B009	No COPCs			NA	NA
RTC	B010	Benzo(a)pyrene equivalents	182.26	µg/kg	NA	3.02



LEGEND

- NO COPCs
- < 1E-6
- 1E-6 to 5E-6
- 5E-6 to 1E-5
- 1E-5 to 1E-4
- > 1E-4

60 0 60 120 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.12.8
ZONE I
SWMU 177 & RTC

SURFACE SOIL POINT RISK
INDUSTRIAL SCENARIO

Table 10.12.23
Point Estimates of Risk and Hazard - Surface Soil Pathways
Site Worker Scenario
SWMU 177/RTC
Charleston Naval Complex
Charleston, South Carolina

SWMU	Location	Parameter	Concentration	Units	Hazard Index	Risk (E-06)
177	B001	No COPCs			NA	NA
177	B002	No COPCs			NA	NA
177	B003	No COPCs			NA	NA
177	B004	No COPCs			NA	NA
177	B005	No COPCs			NA	NA
177	B006	No COPCs			NA	NA
177	B007	No COPCs			NA	NA
177	B008	No COPCs			NA	NA
177	B009	No COPCs			NA	NA
177	B010	Benzo(a)pyrene equivalents	1274	µg/kg	NA	4.29
177	B011	No COPCs			NA	NA
177	B012	Benzo(a)pyrene equivalents	98.488	µg/kg	NA	0.33
177	B013	Benzo(a)pyrene equivalents	17.619	µg/kg	NA	0.06
177	B014	Benzo(a)pyrene equivalents	2.417	µg/kg	NA	0.01
177	B015	No COPCs			NA	NA
177	B016	Benzo(a)pyrene equivalents	4.1	µg/kg	NA	0.01
177	B018	No COPCs			NA	NA
177	B018	Benzo(a)pyrene equivalents	64.93	µg/kg	NA	0.22
RTC	B001	No COPCs			NA	NA
RTC	B002	No COPCs			NA	NA
RTC	B003	No COPCs			NA	NA
RTC	B004	No COPCs			NA	NA
RTC	B005	No COPCs			NA	NA
RTC	B006	No COPCs			NA	NA

Table 10.12.23
Point Estimates of Risk and Hazard - Surface Soil Pathways
Site Worker Scenario
SWMU 177/RTC
Charleston Naval Complex
Charleston, South Carolina

SWMU	Location	Parameter	Concentration	Units	Hazard Index	Risk (E-06)
RTC	B007	No COPCs			NA	NA
RTC	B008	No COPCs			NA	NA
RTC	B009	No COPCs			NA	NA
RTC	B010	Benzo(a)pyrene equivalents	182.26	µg/kg	NA	0.61

10.12.7 Corrective Measures Considerations

Based on the analytical results and the human health risk assessment for SWMU 177/RTC, COCs requiring further evaluation through the CMS process have been identified for surface soil and groundwater. The site is currently in a moderately developed urban setting and risk to human health was evaluated under both the future residential and industrial (site worker) scenarios. For these scenarios, the incidental ingestion and dermal contact exposure pathways were evaluated. Hazard was evaluated for noncarcinogenic contaminants through incidental ingestion and dermal contact scenarios as well.

As recommended by SCDHEC, a COC is considered to be any chemical contributing to a cumulative risk level of 1E-06 or greater and/or a cumulative hazard index above 1.0, if its individual risk exceeds 1E-06 or its hazard quotient exceeds 0.1.

BEQ was identified as a soil pathway COC for SWMU 177/RTC. No COPCs were identified for groundwater at SWMU 177/RTC based on the screening criteria. Table 10.12.25 presents cumulative and COC-specific exposure risks and hazard quotients.

Risk-based remedial goals for surface soil and groundwater are presented in Table 10.12.24. Potential corrective measures for soil are presented in Table 10.12.26.

Table 10.12.24
Residential-Based Remedial Goal Options Surface Soil
SWMU 177/RTC
Charleston Naval Complex
Charleston, South Carolina

Chemical	Slope Factor (mg/kg-day)$^{-1}$	Reference Dose (mg/kg-day)	EPC mg/kg	Hazard-Based Remedial Goal Options **3** mg/kg	**1** mg/kg	**0.1** mg/kg	Risk-Based Remedial Goal Options **1E-06** mg/kg	**1E-05** mg/kg	**1E-04** mg/kg	Background Concentration mg/kg
Benzo(a)pyrene Equivalents										
Residential	7.3	NA	0.8	ND	ND	ND	0.06	0.6	6	NA
Site Worker	7.3	NA	0.8	ND	ND	ND	0.30	3.0	30	NA

Notes:
EPC Exposure point concentration
NA Not applicable
ND Not determined
\- Remedial goal options were based on the residential lifetime-weighted average for carcinogens. and the child resident for noncarcinogens

Table 10.12.25
SWMU 177/RTC
Cumulative and Chemical-Specific Exposure Risks and Hazard

	Risk		Hazard	
Chemical	**Industrial**	**Residential**	**Industrial**	**Residential**
Soil				
BEQs	2.9E-6	1.4E-5	ND	ND
Cumulative	2.9E-6	1.4E-5	ND	ND

Note:
ND = Not Detected

Table 10.12.26
SWMU 177/RTC
Potential Corrective Measures

Medium	Compounds	Potential Corrective Measures
Soil	BEQs	a) No action b) Excavate, offsite disposal, and monitoring c) Containment/capping

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10.13 Dredged Materials Area

The Dredged Materials Area (DMA) encompasses approximately 68 acres at the southern end of the Charleston Naval Complex. The area, which is confined by a dike, has received materials from dredging operations in both the Cooper River and Shipyard Creek since the 1940s. Several dike relocation projects sponsored by the U.S. Army Corps of Engineers have been completed in the area and are documented in the Charleston Division office. Two spillways in the southern portion of the diked area allow deposited sediments to de-water. The southernmost spillway ultimately discharges to the Cooper River and the western spillway discharges directly to Shipyard Creek. The DMA is bounded on the southwest by West Road and Shipyard Creek and on the east by Juneau Avenue and the Cooper River.

To fulfill the CSI objectives and confirm the presence of any contamination from onsite activities, soil, sediment, surface water, and groundwater were sampled in accordance with the approved final RFI work plan and Section 3 of this report.

10.13.1 Soil Sampling and Analysis

Soil was sampled in one round at the DMA at locations shown on Figure 10.13.1. The *Final Zone I RFI Work Plan* (E/A&H, February 1995) proposed collecting five soil samples from the upper-interval and five from the lower-interval. Instead, only two were collected from the lower-interval, because water table is less than 5 feet bgs; saturated samples were not submitted for analysis. Soil samples were submitted for analysis at DQO Level III for the Standard Suite (VOCs, SVOCs, metals, cyanide, pesticides, PCBs), and organotins. Two samples were duplicated and submitted for Appendix IX analysis at DQO Level IV. Table 10.13.1 summarizes the soil sampling at DMA.

10.13.2 Nature and Extent of Organics and Inorganics in Soil

Organic compound analytical data for soil are summarized in Table 10.13.2. Inorganic analytical data for soil are presented in Table 10.13.3. Table 10.13.4 summarizes analytes detected in surface and subsurface soil at the DMA. Appendix D is a complete analytical data report for all samples collected in Zone I.

Volatile Organic Compounds in Soil

Acetone, toluene, and tetrachloroethene were detected in surface soil at the DMA. None of these detections exceeded its RBC. Toluene was also detected in the subsurface soil (3 μg/kg to 19 μg/kg), far below the SSL.

Semivolatile Organic Compounds in Soil

Five SVOCs were detected in surface soil at the DMA with none exceeding its RBC. No SVOCs were detected in subsurface soil.

In accordance with recent cPAH guidance (USEPA *Interim Supplemental Guidance to RAGS: Region IV Bulletins, Human Health Risk Assessment,* Bulletin No. 2 [USEPA 1995c]) and Section 7 of this report, BEQs were calculated for cPAHs at the DMA. BEQs were calculated for surface soil samples at concentrations ranging from 6.43 μg/kg to 26.6 μg/kg, well below the RBC. No BEQs were calculated for the subsurface soil samples.

Pesticides and PCBs in Soil

Six pesticides were detected in surface soil at the DMA, none exceeded its RBC.

Aroclor-1260 was detected in one sample, DMASB00101, at 60 μg/kg, which is below the residential RBC.

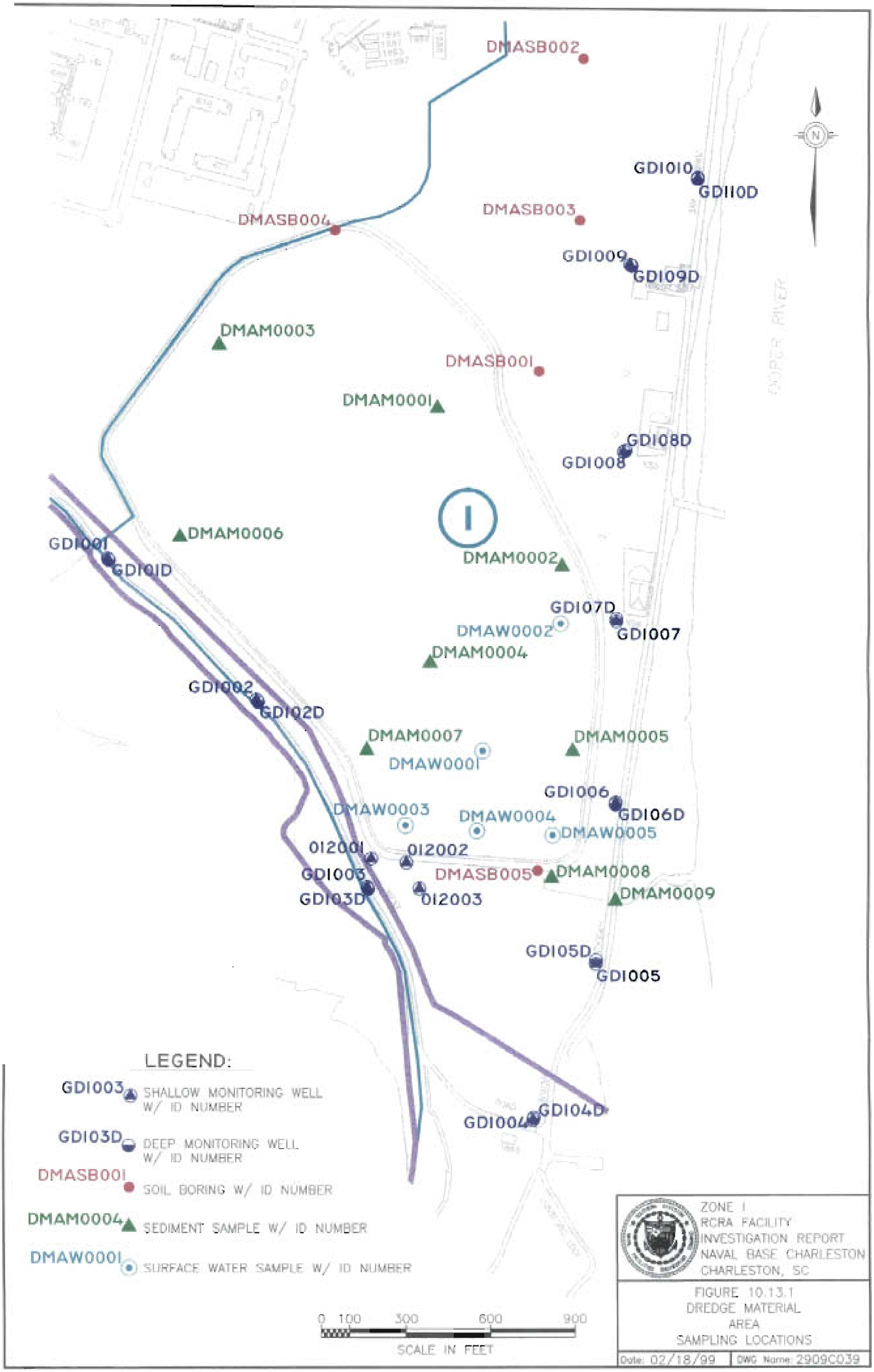

FIGURE 10.13.1
DREDGE MATERIAL AREA
SAMPLING LOCATIONS

Table 10.13.1
DMA
Soil Sampling Summary

Sampling Round	Sampling Date	Samples Collected	Sample Analyses	Comments
1	03/16/95 03/20/95	Upper - 5 (5)	Standard Suite, Organotins	
		Lower - 2 (5)	Standard Suite, Organotins	Three lower samples were not collected due to water table less than 5 feet.
		Duplicates - 2	Appendix IV	

Notes:
( ) = Parentheses indicate number of samples proposed.
Standard Suite = VOCs, SVOCs, metals, cyanide, pesticides, and PCBs were analyzed at DQO Level III.
Physical parameters analysis included CEC, chloride, sulfur, ammonia, nitrate/nitrite, phosphorus, TOC, and total moisture.

Table 10.13.2
DMA
Organic Compound Analytical Results for Soil (μg/kg)

Parameters	Sample Interval	Detection Frequency	Detection Range	Mean	RBC (upper) SSL (lower)	Number of Samples Exceeding RBC or SSL
Volatile Organic Compounds						
Acetone	Upper	1/5	5	NA	780,000	0
	Lower	0/2	ND	NA	8,000	0
Toluene	Upper	3/5	2.0 - 3.0	2.67	1,600,000	0
	Lower	2/2	2.5 - 19.0	10.7	6,000	0
Tetrachloroethene	Upper	1/5	1	1	12,000	0
	Lower	0/2	ND	NA	30	0
Semivolatile Organic Compounds						
BEQs	Upper	3/5	6.43 - 26.6	13.3	87	0
	Lower	0/2	ND	ND	1,600	0
Benzo(b)fluoranthene	Upper	3/5	58.0 - 61.0	59.7	870	0
	Lower	0/2	ND	ND	2,500	0
Benzo(a)pyrene	Upper	1/5	20.0	20.0	87	0
	Lower	0/2	ND	ND	4,000	0
Benzo(k)fluoranthene	Upper	3/5	60.0 - 66.0	63.0	8,700	0
	Lower	0/2	ND	ND	25,000	0
Di-n-butylphthalate	Upper	3/5	51.0 - 56.0	54.0	780,000	0
	Lower	0/2	ND	ND	2,300,000	0

Table 10.13.2
DMA
Organic Compound Analytical Results for Soil (μg/kg)

Parameters	Sample Interval	Detection Frequency	Detection Range	Mean	RBC (upper) SSL (lower)	Number of Samples Exceeding RBC or SSL
bis(2-Ethylhexyl)phthalate (BEHP)	Upper	3/5	80.0 - 330.0	187	46,000	0
	Lower	0/2	ND	ND	1,800,000	0
Pesticides and PCBs						
Aroclor-1260	Upper	1/5	60	60	320	0
	Lower	0/2	ND	ND	1,000	0
Disulfoton	Upper	1/5	3.4	3.4	310	0
	Lower	0/2	ND	ND		
Endrin aldehyde	Upper	1/5	3.0	3.0	2,300	0
	Lower	0/2	ND	ND	340	0
beta-BHC	Upper	4/5	1.9 - 3.8	2.55	350	0
	Lower	0/2	ND	ND	1.3	0
delta-BHC	Upper	1/5	24.0	24.0	350	0
	Lower	0/2	ND	ND	1.8	0
Endosulfan Sulfate	Upper	1/5	6.30	6.30	47,000	0
	Lower	0/2	ND	ND	4,600	0
4,4-DDD	Upper	1/5	7.10	7.10	2,700	0
	Lower	0/2	ND	ND	8,000	0
Dioxins						
TEQ	Upper	2/2	2.86E-4 - 4.98E-4	3.92E-4	4.3E-3	0
	Lower	0/0	ND	ND	1.6	0
1234678-HpCDD	Upper	2/2	1.25E-2 - 2.34E-2	1.79E-2	0.43	0
	Lower	0/0	ND	ND	108	0
1234678-HpCDF	Upper	2/2	1.93E-3 - 50E-3	3.47E-3	0.43	0
	Lower	0/0	ND	ND	54	0
OCDD	Upper	2/2	1.38E-1 - 2.04E-1	1.71E-1	4.3	0
	Lower	0/0	ND	ND	1,080	0
OCDF	Upper	2/2	3.97E-3 - 9.72E-3	6.84E-3	4.3	0
	Lower	0/0	ND	ND	540	0

Notes:
NA = Not Applicable/Not Available/Not Analyzed
ND = Not Detected/Not Determined
NL = Not Listed
μg/kg = Micrograms per kilogram
See Table 5.5 for organic compound screening concentrations and their sources.

Table 10.13.3
DMA
Inorganic Analytical Results for Soil (mg/kg)

Parameters	Sample Interval	Detection Frequency	Detection Range	Mean	Background Concentration	RBC (upper) SSL (lower)	Number of Samples Exceeding: RBC & Background (upper) or SSL & Background (lower)
Aluminum (Al)	Upper	5/5	787 - 39,400	16,809	27,400	7,800	1
	Lower	2/2	4,520 - 33,200	18,860	18,900	560,000	0
Antimony (Sb)	Upper	3/5	0.29 - 0.44	0.35	ND	3.1	0
	Lower	1/2	0.33	0.33	ND	2.7	0
Arsenic (As)	Upper	3/5	11.4 - 14.8	12.6	21.6	0.43	0
	Lower	2/2	4.8 - 21.3	13.1	6.45	15	1
Barium (Ba)	Upper	5/5	5.9 - 48.3	23.9	54.2	550	0
	Lower	2/2	6.7 - 41.2	23.9	36	820	0
Beryllium (Be)	Upper	5/5	0.15 - 1.3	0.67	0.95	16	0
	Lower	2/2	0.25 - 1.2	0.73	0.67	32	0
Cadmium (Cd)	Upper	3/5	0.60 - 1.19	0.89	0.61	7.8	0
	Lower	2/2	0.43 - 0.55	0.49	0.54	4	0
Hexavalent chromium	Upper	1/2	0.628	0.628	ND	39	0
	Lower	0/0	ND	ND	ND	19	0
Chromium (Cr)	Upper	5/5	4.1 - 59.5	32.5	34.5	39	3
	Lower	2/2	34.5 - 57.6	46.1	51.3	19	1
Cobalt (Co)	Upper	5/5	0.42 - 7.9	3.91	5.8	470	0
	Lower	2/2	0.95 - 7.70	4.33	3.48	990	0
Copper (Cu)	Upper	3/5	17.7 - 31.1	24.1	240	310	0
	Lower	2/2	9.6 - 29.1	19.4	11.5	5,600	0
Iron (Fe)	Upper	5/5	1,750 - 34,100	16,386	NL	NL	NA
	Lower	2/2	3,970 - 33,200	18,585	NL	NL	NA
Lead (Pb)	Upper	3/5	18.6 - 31.2	24.4	203	400	0
	Lower	1/2	28.3	28.3	12.3	400	0
Manganese (Mn)	Upper	5/5	25.3 - 475	244	419	160	0
	Lower	2/2	41.9 - 815	428	118	480	1

Table 10.13.3
DMA
Inorganic Analytical Results for Soil (mg/kg)

Parameters	Sample Interval	Detection Frequency	Detection Range	Mean	Background Concentration	RBC (upper) SSL (lower)	Number of Samples Exceeding: RBC & Background (upper) or SSL & Background (lower)
Mercury (Hg)	Upper	2/5	0.14 - 0.24	0.19	0.47	2.3	0
	Lower	1/2	0.24	0.24	ND	1	0
Nickel (Ni)	Upper	5/5	0.58 - 17.7	10.4	23.9	160	0
	Lower	2/2	14.8 - 15.8	15.3	15.7	65	0
Potassium (K)	Upper	5/5	111 - 2,785	1,528	NL	NL	NA
	Lower	2/2	1180 - 2,460	1,820	NL	NL	NA
Selenium (Se)	Upper	3/5	1.10 - 2.05	1.57	1.49	39	0
	Lower	2/2	1.3 - 2.2	1.75	1.77	2.6	0
Sodium (Na)	Upper	1/5	261	261	NL	NL	NA
	Lower	1/2	1,630	1,630	NL	NL	NA
Tin (Sn)	Upper	2/5	1.4 - 2.0	1.7	7.5	4,700	0
	Lower	0/2	ND	ND	ND	5,500	0
Vanadium (V)	Upper	5/5	2.6 - 75.4	34.2	113	55	0
	Lower	2/2	18.4 - 66.2	42.3	38.1	3,000	0
Zinc (Zn)	Upper	4/5	6.7 - 92.2	59.9	206	2,300	0
	Lower	2/2	35.8 - 93.8	64.8	36.2	6,200	0

Note:
NA = Not Applicable/Not Available
ND = Not Detected/Not Determined
NL = Not Listed
mg/kg = Milligrams per kilogram
See Table 5.6 for inorganic element screening concentrations and their sources.

Table 10.13.4
AOC DMA
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Volatile Organic Compounds (μg/kg)							
Acetone	DMASB003	5	780000	NA	NT	8000	NA
	DMAM0003	46			NT		
	DMAM0006	38			NT		
	DMAM0009	28			NT		
Tetrachloroethene (PCE)	DMASB003	1	12000	NA	NT	30	NA
Toluene	DMASB002	3	1600000	NA	3	6000	NA
	DMASB004	2			19		
	DMASB005	2			NT		
Semivolatile Organic Compounds (μg/kg)							
Benzo(a)pyrene Equivalents	DMASB001	26.6	87	NA	NT	1600	NA
(BEQs)	DMASB004	6.76			ND		
	DMASB005	6.43			NT		
	DMAM0004	29.8			NT		
	DMAM0006	21.3			NT		
	DMAM0007	28.9			NT		
Benzo(a)anthracene	DMAM0004	130	870	NA	NT	800	NA
	DMAM0006	89			NT		
	DMAM0007	110			NT		

Table 10.13.4
AOC DMA
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Benzo(a)pyrene	DMASB001	20	87	NA	NT	4000	NA
Benzo(b)fluoranthene	DMASB001	60	870	NA	NT	2500	NA
	DMASB004	61			NT		
	DMASB005	58			NT		
	DMAM0004	150			NT		
	DMAM0006	110			NT		
	DMAM0007	160			NT		
Benzo(k)fluoranthene	DMASB001	60	8700	NA	NT	25000	NA
	DMASB004	66			ND		
	DMASB005	63			NT		
	DMAM0004	170			NT		
	DMAM0006	130			NT		
	DMAM0007	180			NT		
Chrysene	DMAM0004	130	87000	NA	NT	80000	NA
	DMAM0006	110			NT		
	DMAM0007	110			NT		
Di-n-butylphthalate	DMASB001	55	780000	NA	NT	2300000	NA
	DMASB002	51			ND		
	DMASB005	56			NT		

Table 10.13.4
AOC DMA
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
bis(2-Ethylhexyl)phthalate	DMASB001	80	46000	NA	NT	1800000	NA
(BEHP)	DMASB003	150			NT		
	DMASB005	330			NT		
Fluoranthene	DMAM0003	140	310000	NA	NT	2100000	NA
	DMAM0004	250			NT		
	DMAM0005	94			NT		
	DMAM0006	170			NT		
	DMAM0007	200			NT		
Pyrene	DMASB001	30	230000	NA	NT	2100000	NA
	DMAM0003	140			NT		
	DMAM0004	340			NT		
	DMAM0005	120			NT		
	DMAM0006	200			NT		
	DMAM0007	200			NT		
	DMAM0009	79			NT		
Pesticides/PCBs (μg/kg)							
Aroclor-1260	DMASB001	42	320	NA	NT	1000	NA
beta-BHC (beta-HCH)	DMASB001	1.9	350	NA	NT	1.3	NA
	DMASB002	3.8			ND		
	DMASB004	2.6			ND		
	DMASB005	1.9			NT		

Table 10.13.4
AOC DMA
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
delta-BHC (delta-HCH)	DMASB005	24	350	NA	NT	1.8	NA
4,4'-DDD	DMASB005	7.1	2700	NA	NT	8000	NA
	DMAM0008	31			NT		
4,4'-DDE	DMAM0008	34	1900	NA	NT	27000	NA
Endosulfan sulfate	DMASB005	6.3	47000	NA	NT	4600	NA
Endrin aldehyde	DMASB001	3	2300	NA	NT	340	NA
	DMAM0008	67			NT		
Organophosphate Pesticides (μg/kg)							
Disulfoton	DMASB001	3.4	310	NA		39	NA
Organotin (μg/kg)							
Dibutyltin	DMAM0008	8.7	2300	NA	NT	NA	NA
Monobutyltin	DMAM0008	4.5	2300	NA	NT	NA	NA
Tetrabutyltin	DMAM0004	87	2300	NA	NT	NA	NA
	DMAM0005	49.8			NT		
Tributyltin	DMAM0003	17.6	2300	NA	NT	NA	NA
	DMAM0004	25.8			NT		
	DMAM0005	15			NT		
	DMAM0006	16.3			NT		

Table 10.13.4
AOC DMA
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Tributyltin (Continued)	DMAM0007	29.2			NT		
	DMAN0008	71.4			NT		
	DMAM0009	12.2			NT		
Dioxin Compounds (ng/kg)							
2,3,7,8-TCDD equivalents	DMASB001	0.286	4.3	NA	NT	1600	NA
(TEQs)	DMASB002	0.498			NT		
1234678-HpCDD	DMASB001	12.498	430	NA	NT	108000	NA
	DMASB002	23.387			NT		
OCDD	DMASB001	137.575	4300	NA	NT	1080000	NA
	DMASB002	204.116			NT		
1234678-HpCDF	DMASB001	1.93	430	NA	NT	54000	NA
	DMASB002	5.003			NT		
OCDF	DMASB001	3.967	4300	NA	NT	540000	NA
	DMASB002	9.722			NT		
Inorganics (mg/kg)							
Aluminum (Al)	DMASB001	39400	7800	27400	NT	560000	18900
	DMASB002	19900			**33200**		
	DMASB003	787			NT		
	DMASB004	23000			4520		
	DMASB005	957			NT		

Table 10.13.4
AOC DMA
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Aluminum (Al) (Continued)	DMAM0001	6010			NT		
	DMAM0002	23300			NT		
	DMAM0003	**33000**			NT		
	DMAM0004	**33600**			NT		
	DMAM0005	25200			NT		
	DMAM0006	**39500**			NT		
	DMAM0007	**32500**			NT		
	DMAM0008	26900			NT		
	DMAM0009	19500			NT		
Antimony (Sb)	DMASB001	0.44	3.1	ND	NT	2.7	ND
	DMASB002	0.29			ND		
	DMASB004	0.32			0.33		
Arsenic (As)	DMASB001	14.8	0.43	21.6	NT	15	6.45
	DMASB002	11.45			**21.3**		
	DMASB004	11.4			4.8		
	DMAM0001	3			NT		
	DMAM0002	10.6			NT		
	DMAM0003	16.7			NT		
	DMAM0004	15.8			NT		

Table 10.13.4
AOC DMA
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Arsenic (As) (Continued)	DMAM0005	10.6			NT		
	DMAM0006	16.7			NT		
	DMAM0007	15.3			NT		
	DMAM0008	15.4			NT		
	DMAM0009	10.6			NT		
Barium (Ba)	DMASB001	48.35	550	54.2	NT	820	36
	DMASB002	29.25			41.2		
	DMASB003	5.9			NT		
	DMASB004	28.7			6.7		
	DMASB005	7.1			NT		
	DMAM0001	12.7			NT		
	DMAM0002	32.4			NT		
	DMAM0003	38.7			NT		
	DMAM0004	39.8			NT		
	DMAM0005	32.4			NT		
	DMAM0006	45.5			NT		
	DMAM0007	38.2			NT		
	DMAM0008	37.2			NT		
	DMAM0009	25.2			NT		

Table 10.13.4
AOC DMA
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Beryllium (Be)	DMASB001	1.3	16	0.95	NT	32	0.67
	DMASB002	0.865			1.2		
	DMASB003	0.15			NT		
	DMASB004	0.84			0.25		
	DMASB005	0.18			NT		
	DMAM0001	0.33			NT		
	DMAM0002	1.15			NT		
	DMAM0003	1.2			NT		
	DMAM0004	1.2			NT		
	DMAM0005	1			NT		
	DMAM0006	1.4			NT		
	DMAM0007	1.1			NT		
	DMAM0008	0.96			NT		
	DMAM0009	0.71			NT		
Cadmium (Cd)	DMASB001	1.185	7.8	0.61	NT	4	0.54
	DMASB002	0.595			0.55		
	DMASB004	0.88			0.43		
	DMAM0002	0.2			NT		

Table 10.13.4
AOC DMA
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Chromium (Cr) (total)	DMASB001	69	39	34.5	NT	19	51.3
	DMASB002	41.05			57.6		
	DMASB003	4.1			NT		
	DMASB004	52.5			34.5		
	DMASB005	4.9			NT		
	DMAM0001	23.1			NT		
	DMAM0002	49.35			NT		
	DMAM0003	71			NT		
	DMAM0004	68.6			NT		
	DMAM0005	56.3			NT		
	DMAM0006	84.7			NT		
	DMAM0007	69.4			NT		
	DMAM0008	58			NT		
	DMAM0009	39.2			NT		
Chromium (Cr6) (hexavalent)	DMASB002	0.628	39	ND	ND	19	ND
Cobalt (Co)	DMASB001	7.9	470	5.8	NT	990	3.48
	DMASB002	5.4			7.7		
	DMASB003	0.42			NT		
	DMASB004	5.3			0.95		

Table 10.13.4
AOC DMA
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Cobalt (Co) (Continued)	DMASB005	0.52			NT		
	DMAM0001	2.1			NT		
	DMAM0002	7.15			NT		
	DMAM0003	9.3			NT		
	DMAM0004	8.9			NT		
	DMAM0005	7.9			NT		
	DMAM0006	10.5			NT		
	DMAM0007	8.7			NT		
	DMAM0008	6.5			NT		
	DMAM0009	5.3			NT		
Copper (Cu)	DMASB001	31.1	310	240	NT	5600	11.5
	DMASB002	17.7			29.1		
	DMASB004	23.4			9.6		
	DMAM0001	6.3			NT		
	DMAM0002	14.6			NT		
	DMAM0003	47.2			NT		
	DMAM0004	40.6			NT		
	DMAM0005	28.6			NT		
	DMAM0006	54.1			NT		

Table 10.13.4
AOC DMA
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Copper (Cu) (Continued)	DMAM0007	43.8			NT		
	DMAM0008	29.5			NT		
	DMAM0009	21.9			NT		
Lead (Pb)	DMASB001	31.2	400	203	NT	400	12.3
	DMASB002	18.55			28.3		
	DMASB004	23.3			ND		
	DMAM0001	7			NT		
	DMAM0002	17.55			NT		
	DMAM0003	32.2			NT		
	DMAM0004	31.1			NT		
	DMAM0005	24.1			NT		
	DMAM0006	38.8			NT		
	DMAM0007	30.3			NT		
	DMAM0008	25.4			NT		
	DMAM0009	18.5			NT		
Manganese (Mn)	DMASB001	475.5	160	419	NT	480	118
	DMASB002	371			**815**		
	DMASB003	25.3			NT		
	DMASB004	318			41.9		

Table 10.13.4
AOC DMA
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Manganese (Mn) (Continued)	DMASB005	30.8			NT		
	DMAM0001	66.5			NT		
	DMAM0002	302			NT		
	DMAM0003	558			NT		
	DMAM0004	610			NT		
	DMAM0005	609			NT		
	DMAM0006	602			NT		
	DMAM0007	567			NT		
	DMAM0008	559			NT		
	DMAM0009	542			NT		
Mercury (Hg)	DMASB001	0.24	2.3	0.47	NT	1	ND
	DMASB002	ND			0.24		
	DMASB004	0.14			ND		
Nickel (Ni)	DMASB001	19.75	160	23.9	NT	65	15.7
	DMASB002	13.1			15.8		
	DMASB003	0.58			NT		
	DMASB004	17.7			14.8		
	DMASB005	0.65			NT		
	DMAM0001	7.5			NT		

Table 10.13.4
AOC DMA
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Nickel (Ni) (Continued)	DMAM0002	12.5			NT		
	DMAM0003	17.9			NT		
	DMAM0004	17.9			NT		
	DMAM0005	15.3			NT		
	DMAM0006	22.3			NT		
	DMAM0007	18.2			NT		
	DMAM0008	16.4			NT		
	DMAM0009	11.8			NT		
Selenium (Se)	DMASB001	2.05	39	1.49	NT	2.6	1.77
	DMASB002	1.55			2.2		
	DMASB004	1.1			1.3		
	DMAM0001	1			NT		
	DMAM0002	1.4			NT		
	DMAM0003	1.8			NT		
	DMAM0004	2.7			NT		
	DMAM0005	1.9			NT		
	DMAM0006	2			NT		
	DMAM0007	2.4			NT		
	DMAM0008	2			NT		
	DMAM0009	1.4			NT		

Table 10.13.4
AOC DMA
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Tin (Sn)	DMASB003	1.4	4700	7.5	NT	5500	ND
	DMASB005	2			NT		
Vanadium (V)	DMASB001	75.45	55	113	NT	3000	38.1
	DMASB002	41.8			**66.2**		
	DMASB003	2.6			NT		
	DMASB004	48.1			18.4		
	DMASB005	3.2			NT		
	DMAM0001	14.3			NT		
	DMAM0002	43.95			NT		
	DMAM0003	66.9			NT		
	DMAM0004	62.5			NT		
	DMAM0005	48.4			NT		
	DMAM0006	73.5			NT		
	DMAM0007	60.4			NT		
	DMAM0008	50.4			NT		
	DMAM0009	34.4			NT		

Table 10.13.4
AOC DMA
Analytes Detected in Surface and Subsurface Soil

Parameter	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil-to-Groundwater SSL* (DAF=10)	Subsurface Background
Zinc (Zn)	DMASB001	92.45	2300	206	NT	6200	36.2
	DMASB002	63.05			93.8		
	DMASB004	77.5			35.8		
	DMASB005	6.7			NT		
	DMAM0001	25.2			NT		
	DMAM0002	63			NT		
	DMAM0003	115			NT		
	DMAM0004	105			NT		
	DMAM0005	91			NT		
	DMAM0006	136			NT		
	DMAM0007	111			NT		
	DMAM0008	93.4			NT		
	DMAM0009	67.5			NT		

Notes:

a	=	Background value for non clay samples
*	=	Residential RBCs (THQ=0.1) were used as a reference concentration for upper-interval samples. Generic soil-to groundwater SSLs (DAF = 10) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996b) were used as s reference concentration for lower-interval samples.

Bold concentrations exceed the RBCs, SSL, and the zone background.

All background values for Zone I are based on twice the means of the grid sample concentrations. Background values for the groundwater are based on two sampling rounds in two wells at each depth.

NA	=	Not Applicable/Not Available
ND	=	Not Detected
NT	=	Not taken
RBC	=	Risk-based concentration
SSL	=	Soil screening level
ng/kg	=	Nanograms per kilogram
μg/kg	=	Micrograms per kilogram
mg/kg	=	Milligrams per kilogram

Other Organic Compounds in Soil

Dioxins were detected in both duplicate samples collected at the DMA. In accordance with recent dioxin guidance (USEPA *Interim Supplemental Guidance to RAGS: Region IV Bulletins Human Health Risk Assessment*, Bulletin No. 2 [USEPA 1995c]), and Section 7 of this report, TEQs were calculated. The calculated TEQs for the surface soil samples were 2.86E-4 μg/kg and 4.98E-4 μg/kg, well below the RBC. No subsurface soil samples were collected for dioxins.

Inorganics in Soil

Twenty-one metals were detected in surface soil at the DMA. Aluminum was detected in one surface soil sample (DMASB00101) at 39,400 mg/kg, which exceeds both the RBC and background levels. Chromium concentrations in samples DMASB00101 (69.0 mg/kg), DMASB00201 (41.1 mg/kg), and DMASB00401 (52.5 mg/kg) exceeded both the background and RBC. No other inorganic exceedances were observed in the surface soil samples.

Similar inorganics were detected in subsurface soils, along with hexavalent chromium and tin. Arsenic (21.3 mg/kg), chromium (57.6 mg/kg), and manganese (815 mg/kg) exceeded both their background and SSL values. These exceedances were detected in boring DMASB002.

10.13.3 Sediment Sampling and Analysis

Sediment was sampled in one round in accordance with final Zone I RFI work plan. As proposed in the work plan, nine sediment samples were collected from the locations shown on Figure 10.13.1. Some sampling locations were changed from the work plan because the proposed locations were in accessible. Samples were submitted for analysis at DQO Level III for standard suite (VOCs, SVOCs, metals, cyanide, pesticides, PCBs), organotins, TOC, and grain size. One sample (DMAM00201) was duplicated and submitted for the standard suite, TOC, grain size and organotins. Table 10.13.5 summarizes the sediment sampling and analysis at the DMA.

Table 10.13.5
DMA
Soil Sampling Summary

Sampling Round	Sampling Date	Samples Collected	Sample Analyses	Comments
I	03/30/95 04/04/95 04/05/95	9 (9)	Standard Suite, TOC, Grain Size, Organotins	
		Duplicate - 1	Standard Suite, TOC, Grain Size, Organotins	

Notes:
( ) = Parentheses indicate number of samples proposed.
Standard suite = VOCs, SVOCs, metals, cyanide, pesticides, and PCBs at DQO Level III.

10.13.4 Nature and Extent of Contamination in Sediment

Organic analytical results are summarized in Table 10.13.6. Inorganic analytical results are summarized in Table 10.13.7. Table 10.13.4 summarizes analtyes detected in sediments at the DMA. Appendix D is a complete analytical data report for all samples collected in Zone I, including the DMA. Appendix B is a complete geotechnical report for grain size analyses.

Table 10.13.6
DMA
Organic Compound Analytical Results for Sediment (μg/kg)

Parameter	Frequency of Detections	Range of Detections	Mean
Volatile Organic Compounds			
Acetone	3/9	28.0 - 46.0	37.3
Semivolatile Organic Compounds			
BEQ	3/9	21.3 - 29.8	26.7
Benzo(a)anthracene	3/9	89.0 - 130	109.7
Benzo(b)fluoranthene	3/9	110 - 160	140
Benzo(k)fluoranthene	3/9	130 - 180	160
Chrysene	3/9	110 - 130	117
Fluoranthene	5/9	94.0 - 250	171
Pyrene	6/9	79.0 - 340	180

Table 10.13.6
DMA
Organic Compound Analytical Results for Sediment (μg/kg)

Parameter	Frequency of Detections	Range of Detections	Mean
Pesticides and PCBs			
4,4'-DDD	1/9	31	31
4,4'-DDE	1/9	34	34
Endrin aldehyde	1/9	67	67
Organotins			
Dibutyltin	1/9	8.7	8.7
Monobutyltin	1/9	4.5	4.5
Tetrabutyltin	2/9	49.8 - 87.0	68.4
Tributyltin	7/9	12.2 - 71.4	26.8

Note:
μg/kg = microgram per kilogram

Table 10.13.7
DMA
Inorganic Analytical Results for Sediment (mg/kg)

Parameter	Frequency of Detections	Range of Detections	Mean
Inorganics			
Aluminum (Al)	9/9	6,010 - 39,500	26,612
Arsenic (Ar)	9/9	3.0 - 16.7	12.74
Barium (Ba)	9/9	12.7 - 45.5	33.6
Beryllium (Be)	9/9	0.33 - 1.4	1.0
Cadmium (Cd)	1/9	0.2	0.2
Calcium (Ca)	9/9	9,825 - 53,600	28,081
Chromium (Cr)	9/9	23.1 - 84.7	57.7
Cobalt (Co)	9/9	2.1 - 10.5	7.37
Copper (Cu)	9/9	6.3 - 54.1	31.84
Lead (Pb)	9/9	7.0 - 38.8	25.99
Magnesium (Mg)	9/9	2,950 - 9,460	6,222

Table 10.13.7
DMA
Inorganic Analytical Results for Sediment (mg/kg)

Parameter	Frequency of Detections	Range of Detections	Mean
Manganese (Mn)	9/9	66.5 - 610	490
Nickel (Ni)	9/9	7.5 - 22.3	15.5
Potassium (K)	9/9	1,220 - 4,630	3,144
Selenium (Se)	9/9	1.0 - 2.7	1.84
Sodium (Na)	9/9	2,720 - 14,200	7,867
Vanadium (V)	9/9	14.3 - 73.5	50.5
Zinc (Zn)	9/9	25.2 - 136	89.7
TOC	9/9	6,770 - 15,200	10,457

Note:
mg/kg = milligram per kilogram

Volatile Organic Compounds in Sediment

Acetone was the only VOC detected in sediment samples from the DMA. It was detected in samples DMAM00401 (46 μg/kg), DMAM00601 (38 μg/kg), and DMAM00901 (28 μg/kg).

Semivolatile Organic Compounds in Sediment

Several PAHs, including benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, fluoranthene, and pyrene were detected in DMA sediments. Pyrene was detected in one sample (DMAM00401) at a concentration of 340 μg/kg.

BEQs were calculated for three of the nine sediment samples collected. The calculated BEQs ranged from 21.3 μg/kg to 29.8 μg/kg.

Pesticides and PCBs in Sediment

Three pesticides were detected in DMA sediment samples. 4,4'-DDD and 4,4'-DDE were detected in sample DMAM00801 at concentrations of 31.0 and 34.0 μg/kg respectively.

Other Organic Compounds in Sediment

Several organotins were detected in DMA sediment samples. Tributylin was detected in seven of nine samples at concentrations ranging from 12.2 μg/kg to 71.4 μg/kg.

Inorganics in Sediment

Eighteen metals were detected in DMA sediments. Except for cadmium, metals were detected in all nine sample locations.

10.13.5 Surface Water Sampling and Analysis

Surface water was sampled in accordance with the final work plan and Section 3 of this report. As proposed in the work plan, five surface water samples were collected from the locations shown on Figure 10.13.1. Sample locations varied from the proposed locations due to inaccessibility. Field parameters (i.e., pH, conductivity, turbidity, and temperature) were not measured because the surface water was less than 3 feet deep. Samples were collected for VOC, SVOC, metal, cyanide, pesticide, PCB, and organotin analysis. Table 10.13.8 summarizes the surface water sampling and analysis at the DMA.

Table 10.13.8
DMA
Surface Water Sampling Summary

Sampling Round	Sampling Date	Samples Collected	Sample Analyses	Comments
1	04/04/95	5 (5)	Standard suite, organotins	
		Duplicate - 1	Standard suite, organotins	

Notes:
( ) = Parentheses indicate number of samples proposed.
Standard Suite = VOCs, SVOCs, metals, cyanide, pesticides, and PCBs at DQO Level III..

10.13.6 Nature and Extent of Contamination in Surface Water

Organic compound analytical results for surface water are summarized in Table 10.13.9. Inorganic analytical results are summarized in Table 10.13.10. Table 10.13.11 summarizes analytes detected in surface water at the DMA. Appendix D is a complete analytical report for all samples collected in Zone I.

Table 10.13.9
DMA
Organic Analytical Results for Surface Water (μg/L)

Parameter	Frequency of Detections	Range of Detections	Mean
Volatile Organic Compounds			
Acetone	2/5	6.0 - 12.0	9
Semivolatile Organic Compounds			
Phenol	1/5	19.5	19.5

Note:
μg/L = microgram per liter

Table 10.13.10
DMA
Inorganic Analytical Results for Surface Water (μg/L)

Parameter	Frequency of Detections	Range of Detections	Mean
Inorganics			
Aluminum (Al)	5/5	364 - 15,700	7,461
Arsenic (As)	1/5	26.3	26.3
Barium (Ba)	5/5	25.8 - 53.1	43.8
Cadmium (Cd)	1/5	0.905	0.905
Calcium (Ca)	5/5	236,000 - 298,000	279,400
Chromium (Cr)	5/5	4.1 - 26.5	14.4
Cobalt (Co)	4/5	1.5 - 3.65	2.19
Copper (Cu)	5/5	4.8 - 18.3	11.6
Iron (Fe)	5/5	2,020 - 13,500	7,702
Lead (Pb)	5/5	4.3 - 36.1	13.4
Magnesium (Mg)	5/5	237,000 - 352,000	326,200
Manganese (Mn)	5/5	1,650 - 3,540	3,087
Nickel (Ni)	5/5	2.9 - 10.6	6.66
Potassium (K)	5/5	99,500 - 177,500	156,600
Selenium (Se)	5/5	5.0 - 6.90	6.08
Sodium (Na)	5/5	1,500,000 - 2,525,000	2,269,000
Vanadium (V)	5/5	4.7 - 34.6	18.9
Zinc (Zn)	5/5	27.8 - 96.7	55.8

Note:
μg/L = microgram per liter

Table 10.13.11
AOC DMA
Analytes Detected in Surface Water (μg/L)

Parameters	Location	Surface Water Concentration	Tap-water RBC*	MCL/SMCL*	Shallow Background
Volatile Organic Compounds					
Acetone	DMAW0001	6	370	NA	NA
	DMAW0005	12			
Semivolatile Organic Compounds					
Phenol	DMAW0001	19.5	2200	NA	NA
Inorganics					
Aluminum (Al)	DMAW0001	15700	3700	NL	1440
	DMAW0002	5030			
	DMAW0003	9400			
	DMAW0004	6810			
	DMAW0005	364			
Arsenic (As)	DMAW0001	26.3	0.045	50	23
Barium (Ba)	DMAW0001	53.15	260	2000	110
	DMAW0002	45.5			
	DMAW0003	49			
	DMAW0004	45.8			
	DMAW0005	25.8			
Cadmium (Cd)	DMAW0001	0.905	1.8	5	NA

Table 10.13.11
AOC DMA
Analytes Detected in Surface Water ($\mu g/L$)

Parameters	Location	Surface Water Concentration	Tap-water RBC*	MCL/SMCL*	Shallow Background
Chromium (Cr) (total)	DMAW0001	26.55	18	100	14.3
	DMAW0002	11.1			
	DMAW0003	16.8			
	DMAW0004	13.3			
	DMAW0005	4.1			
Cobalt (Co)	DMAW0001	3.65	220	NL	2.2
	DMAW0002	1.6			
	DMAW0003	2			
	DMAW0004	1.5			
Copper (Cu)	DMAW0001	18.35	150	1300	4.4
	DMAW0002	11.3			
	DMAW0003	13.8			
	DMAW0004	9.7			
	DMAW0005	4.8			
Lead (Pb)	DMAW0001	36.05	15	15	4.4
	DMAW0002	6.9			
	DMAW0003	11.3			
	DMAW0004	8.4			
	DMAW0005	4.3			

Table 10.13.11
AOC DMA
Analytes Detected in Surface Water (μg/L)

Parameters	Location	Surface Water Concentration	Tap-water RBC*	MCL/SMCL*	Shallow Background
Manganese (Mn)	DMAW0001	3405	73	NL	5430
	DMAW0002	3410			
	DMAW0003	3540			
	DMAW0004	3430			
	DMAW0005	1650			
Nickel (Ni)	DMAW0001	10.6	73	100	13.3
	DMAW0002	6.3			
	DMAW0003	7.3			
	DMAW0004	6.2			
	DMAW0005	2.9			
Selenium (Se)	DMAW0001	6.9	18	50	ND
	DMAW0002	6.6			
	DMAW0003	6.5			
	DMAW0004	5			
	DMAW0005	5.4			
Vanadium (V)	DMAW0001	34.6	26	NL	14
	DMAW0002	15.1			
	DMAW0003	22.6			
	DMAW0004	17.6			
	DMAW0005	4.7			

Table 10.13.11
AOC DMA
Analytes Detected in Surface Water (μg/L)

Parameters	Location	Surface Water Concentration	Tap-water RBC*	MCL/SMCL*	Shallow Background
Zinc (Zn)	DMAW0001	96.7	1100	NL	24.4
	DMAW0002	58.6			
	DMAW0003	52.9			
	DMAW0004	42.8			
	DMAW0005	27.8			

Notes:
* = Tap-water RBCs (THQ=0.1) from *Risk-Based Concentration Table* (USEPA, October 22, 1997), and MCLs/SMCLs from *Drinking Water Regulations and Health Advisories* (USEPA, 1996e)
Bold concentrations exceed the RBCs, SSL, and the zone background.
All background values for Zone I are based on twice the means of the grid sample concentrations. Background values for the groundwater are based on two sampling rounds in two wells at each depth.
NA = Not applicable/not available
NL = Not listed
NT = Not taken
RBC = Risk-based concentration
SSL = Soil screening level
μg/L = Micrograms per liter

Volatile Organic Compounds in Surface Water

Acetone was detected in two surface water samples at a range of 6.0 μg/L to 12.00 μg/kg. No other VOCs were detected in surface waters at the DMA.

Semivolatile Organic Compounds in Surface Water

Phenol was detected in surface water at 17.0 μg/L. No other SVOCs were detected in the surface waters at the DMA.

Pesticides and PCBs in Surface Water

No pesticides or PCBs were detected in surface water.

Inorganics in Surface Water

Eighteen metals were detected in surface water samples from the DMA.

10.13.7 Groundwater Sampling and Analysis

No wells were specifically installed to characterize groundwater at the DMA. The final RFI work plan proposed eight grid-based well pairs (GDI001/1D through GDI008/8D) to be installed along the eastern and western boundaries of the DMA to characterize the zone perimeter groundwater. Four rounds of samples were collected from wells GDI001/1D through GDI006/6D and six rounds were collected from wells GDI007/7D and GDI008/8D and analyzed for VOCs, SVOC, metals, cyanide, pesticides, PCBs, chloride, sulfate, and TDS at DQO Level III. These wells were also sampled for dioxins. Results of these analyses are discussed in the following nature and extent section and are presented in Appendix D.

10.13.8 Nature and Extent of Organic Compounds and Inorganics in Groundwater

The shallow grid-based monitoring wells were installed from 12.5 feet bgs to 12.4 feet bgs in the upper sand layer of the Wando Formation. The deep grid-based wells were installed from

43.9 feet bgs to 68.5 feet bgs. The grid well locations are noted on Figure 10.13.1. All wells were installed in accordance with Section 3 of this report.

The complete analytical data reports for all grid-based samples collected at Zone I are presented in Appendix D.

Volatile Organic Compounds in Groundwater

Six VOCs were detected in the shallow groundwater samples from the grid-based wells at DMA. Only one VOC – 1,1,2,2-tetrachloroethane – exceeded the tap-water RBC. This detection was in well GDI007, in the fourth sample round, at 1.0 μg/L.

Acetone, carbon disulfide, and xylene (total) were also detected in deep well samples. All detections were below their RBCs and/or MCLs.

Semivolatile Organic Compounds in Groundwater

Five SVOCs were detected in the shallow grid wells at the DMA: acenaphthene, acetophenone, benzoic acid, bis(2-ethylhexyl)phthalate, di-n-butylphthalate, and fluorene. Acetophenone was detected once in well GDI003 in the first-round at 1.0 μgL, which exceeds the RBC. Bis(2-ethylhexyl)phthalate was detected GDI001, first-round, and GDI007, third round, at 15 μg/L and 11 μg/L. Both detections exceeded the RBC. No other SVOCs were detected in the shallow groundwater at the DMA.

Four SVOCs were detected in the deep well samples. Bis(2-ethylhexyl)phthalate exceeded its RBC and/or MCL in GDI05D, in the second-round, at 380 μg/L. None of the other SVOCs detected exceeded their RBCs and/or MCLs.

Pesticides/PCBs in Groundwater

Beta-BHC was detected in one shallow well sample at GDI008 in the first-round. The detection (0.022 μg/L) was below the RBC. No other pesticides were detected in the shallow groundwater from these grid-based wells.

Beta-BHC was also detected in a deep well sample in GDI06D in the first-round at 0.052 μg/L. Aroclor-1260 was detected in one deep well sample in GDI01D in the second-round, at 1 μg/L. This detection exceeds the RBC. No other pesticides or PCBs were detected in the deep groundwater from these grid-based wells.

Other Organic Compounds in Groundwater

Dioxins were detected in five of the shallow grid-based monitoring wells during the four rounds of sampling. In accordance with recent dioxin guidance (USEPA 1995c) and Section 7 of this report, TEQs were calculated ranging from 8.9E-9 μg/L to 3.41E-6 μg/L, concentrations well below the tap-water RBC of 4.5E-4 μg/L.

Dioxins were also detected in five of the deep grid-based monitoring wells. TEQs were calculated ranging from 1.67F-8 μg/l to 1.67E-6 μg/l, well below the RBC.

Inorganic Elements in Groundwater

Twenty metals were detected in shallow grid-based groundwater samples over the sampling rounds. Seven of the 20 exceeded their screening levels. Antimony exceeded its RBC (1.5 μg/L) during the third round of sampling in well GDI002 at 3.1 μg/L, in well GDI003 at 3.1 μg/L, in well GDI006 at 3.1 μg/L, and in well GDI008 at 5.6 μg/L. Antimony was also detected in GDI006 in the fourth-round at 8. 4 μg/L. Cadmium exceeded its RBC (1.8 μg/L) during the second-round in well GDI007 (2.3 μg/L). Chromium exceeded its RBC (18 μg/L) in the third round in well GDI005 at 23.8 μg/L and in the sixth round in well GDI008 at 22.7 μg/L. Lead marginally exceeded its RBC (15 μg/L) during the first-round in well GDI002 at 15.6 μg/L and during the second-round in well GDI007 at 15.7 μg/L. Mercury equaled its RBC (1.1 μg/L) in one sample on the first-round in well GDI002. This was the only detection of mercury in the shallow grid-based wells at the DMA. Selenium exceeded its RBC (18 μg/L) during the sixth round in well GDI007 at 26.7 μg/L. This was the only detection of selenium in the shallow grid-based wells at the DMA. Thallium exceeded its RBC (0.26 μg/L) during the second-round of sampling in well GDI002 at 6.6 μg/L and in the third round of sampling in well GDI001 at 5.5 μg/L, well GDI002 at 3.5 μg/L, well GDI003 at 2.8 μg/L, and well GDI005 at 3.0 μg/L. Thallium was not detected in any other rounds or wells.

Seventeen metals were detected in the deep grid-based well samples at the DMA. Antimony exceeded its MCL (6 μg/L) in the third round in well GDI03D at 6.1 μg/L and in the fifth round in well GDI07D at 9.2 μg/L. Manganese equaled or exceeded its MCL (261 μg/L) in the first-round in well GDI06D at 302 μg/L, in the second-round in well GDI03D at 261 μg/L, and in the fourth-round in well GDI02D at 261 μg/L. Nickel exceeded it MCL (100 μg/L) in the first-round in well GDI05D at 454 μg/L. Thallium exceeded its MCL (2 μg/L) in the second-round in well GDI01D at 5.1 μg/L, in well GDI05D at 5.5 μg/L, in well GDI07D at 5.6 μg/L, and in well GDI08D at 5.5 μg/L. Thallium was also detected in the third round in well GDI02D at 4.2 μg/L.

10.13.9 Fate and Transport Assessment

The DMA encompasses approximately 68 acres at the southern end of the complex. The area, which is confined by a dike, has received materials from dredging operations in both the Cooper River and Shipyard Creek since the 1940s. Several dike relocation projects sponsored by the U.S. Army Corps of Engineers have been completed the area and are documented in files in the Charleston Division office. Two spillways in the southern portion of the diked area allow deposited sediments to de-water. Environmental media sampled as part of this investigation include surface and subsurface soil, sediment, and surface water. Potential constituent migration pathways evaluated for DMA include soil-to-groundwater, soil-to-sediment, and emission of volatiles from surface soil-to-air (groundwater was not sampled; direct exposure to surface water results are considered in the ecological risk assessment).

10.13.9.1 Soil-to-Groundwater Cross-Media Transport

Tables 10.13.12 and 10.13.13 compare maximum detected organic and inorganic concentrations in surface soil and subsurface soil samples to risk-based soil screening levels considered protective of groundwater. Maximum concentrations in soil are compared to leachability-based generic SSLs. Soil background values for Zone I inorganics were determined, but at the request of SCDHEC, they were not considered during initial comparisons of maximum soil concentrations to SSLs. To provide a conservative screen, generic SSLs are used; leachate entering the aquifer is assumed to be diluted by a ratio of 10:1, with no attenuation of constituents in soil (DAF=10).

Two organic constituents - beta-BHC and delta-BHC - exceeded SSLs in site soil. Beta-BHC exceeded the SSL in four of five surface soil samples, but was nondetect in subsurface soil. Only two locations were sampled for subsurface soil due to a high water table; thus, two locations with surface soil exceedances were close to groundwater. Figure 10.13.2 presents beta-BHC concentrations detected at the DMA. Delta-BHC exceeded the SSL in only one of five surface soil samples; it was nondetect in subsurface soil. Figure 10.13.3 presents delta-BHC concentrations detected at the DMA. The presence of both of these constituents is not unexpected at this site, because pesticide application is likely to have been a routine practice due to the standing water. Further, these constituents could have been aerially deposited from an upwind application. Although they are nondetect in subsurface soil, several locations were not sampled; thus, the pathway is valid for these parameters.

Table 10.13.12
Organic Chemicals Detected in Surface Soil, Subsurface Soil, Sediment, and Shallow Groundwater
Comparison to Cross-Media SSLs, Tap-Water RBCs, and Saltwater Surface Water Chronic Screening Levels
Dredged Materials Area
Charleston Naval Complex
Charleston, South Carolina

Parameter	Maximum Concentration				Screening Concentration									
	Surface Soil	Subsurface Soil	Sediment	Surface Water	Soil to GW SSL	Soil to Air SSL	Tap Water RBC	Saltwater Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Volatilization Potential	Ground-water Migration Concern	Surface Water Migration Concern
Volatile Organic Compounds														
Acetone	5	ND	46	12	8000	1.0E+08	3700	NA	µG/KG	µG/L	NO	NO	NO	NO
Tetrachloroethene (PCE) c	1	ND	ND	ND	30	11000	1.1	45	µG/KG	µG/L	NO	NO	NO	NO
Toluene	3	19	ND	ND	6000	650000	750	37	µG/KG	µG/L	NO	NO	NO	NO
Semivolatile Organic Compounds														
Benzo(a)pyrene Equivalents	26.6	ND	29.83	ND	1600 a	NA	0.0092	NA	µG/KG	µG/L	NO	NO	NO	NO
Benzo(a)anthracene c	ND	ND	130	ND	800	NA	0.092	NA	µG/KG	µG/L	NO	NO	NO	NO
Benzo(a)pyrene c	20	ND	ND	ND	4000	NA	0.0092	NA	µG/KG	µG/L	NO	NO	NO	NO
Benzo(b)fluoranthene c	61	ND	160	ND	2500	NA	0.092	NA	µG/KG	µG/L	NO	NO	NO	NO
Benzo(k)fluoranthene c	66	ND	180	ND	25000	NA	0.92	NA	µG/KG	µG/L	NO	NO	NO	NO
Chrysene c	ND	ND	130	ND	80000	NA	9.2	NA	µG/KG	µG/L	NO	NO	NO	NO
Di-n-butylphthalate	56	ND	ND	ND	2300000	2300000	3700	3.4	µG/KG	µG/L	NO	NO	NO	NO
bis(2-Ethylhexyl)phthalate (BEHP) c	330	ND	ND	ND	1800000	31000000	4.8	NA	µG/KG	µG/L	NO	NO	NO	NO
Fluoranthene	ND	ND	250	ND	2100000	NA	1500	1.6	µG/KG	µG/L	NO	NO	NO	NO
Phenol	ND	ND	ND	19.5	50000	NA	22000	58	µG/KG	µG/L	NO	NO	NO	NO
Pyrene	30	ND	340	ND	2100000	NA	1100	NA	µG/KG	µG/L	NO	NO	NO	NO
Pesticides/PCBs														
Aroclor-1260 c	42	ND	ND	ND	1000	1000	0.033	0.03	µG/KG	µG/L	NO	NO	NO	NO
beta-BHC (beta-HCH) c	3.8	ND	ND	ND	1.3	1E+09	0.037	NA	µG/KG	µG/L	YES	NO	NO	NO
delta-BHC (delta-HCH) c	24	ND	ND	ND	1.8 a	NA	0.037	NA	µG/KG	µG/L	YES	NO	NO	NO
4,4'-DDD c	7.1	ND	31	ND	8000	NA	0.28	0.025	µG/KG	µG/L	NO	NO	NO	NO
4,4'-DDE c	ND	ND	34	ND	27000	NA	0.2	0.14	µG/KG	µG/L	NO	NO	NO	NO
Endosulfan sulfate	6.3	ND	ND	ND	4600 a	NA	220	NA	µG/KG	µG/L	NO	NO	NO	NO
Endrin aldehyde	3	ND	67	ND	340 a	NA	11	NA	µG/KG	µG/L	NO	NO	NO	NO
Organophosphate Pesticides														
Disulfoton	3.4	ND	ND	ND	39 a	NA	0.24	NA	µG/KG	µG/L	NO	NO	NO	NO
Organotin														
Dibutyltin	ND	ND	8.7	ND	NA	NA	11	NA	µG/KG	µG/L	NO	NO	NO	NO
Monobutyltin	ND	ND	4.5	ND	NA	NA	11	NA	µG/KG	µG/L	NO	NO	NO	NO
Tetrabutyltin	ND	ND	87	ND	NA	NA	11	NA	µG/KG	µG/L	NO	NO	NO	NO
Tributyltin	ND	ND	71.4	ND	NA	NA	11	0.01	µG/KG	µG/L	NO	NO	NO	NO

Table 10.13.12
Organic Chemicals Detected in Surface Soil, Subsurface Soil, Sediment, and Shallow Groundwater
Comparison to Cross-Media SSLs, Tap-Water RBCs, and Saltwater Surface Water Chronic Screening Levels
Dredged Materials Area
Charleston Naval Complex
Charleston, South Carolina

Parameter	Maximum Concentration				Screening Concentration									
	Surface Soil	Subsurface Soil	Sediment	Surface Water	Soil to GW SSL	Soil to Air SSL	Tap Water RBC	Saltwater Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Volatilization Potential	Ground-water Migration Concern	Surface Water Migration Concern
Dioxin Compounds														
2,3,7,8-TCDD equivalents (TEQs) c	0.498	ND	ND	ND	1600 a	NA	0.45	10	NG/KG	PG/L	NO	NO	NO	NO
1234678-HpCDD c	23.4	ND	ND	ND	108000 a	NA	45	NA	NG/KG	PG/L	NO	NO	NO	NO
OCDD c	204	ND	ND	ND	1080000 a	NA	450	NA	NG/KG	PG/L	NO	NO	NO	NO
1234678-HpCDF c	5	ND	ND	ND	54000 a	NA	45	NA	NG/KG	PG/L	NO	NO	NO	NO
OCDF c	9.7	ND	ND	ND	540000 a	NA	450	NA	NG/KG	PG/L	NO	NO	NO	NO

Notes:
Sources of screening concentrations appear in Table 5.5
Explanations of fate and transport screening procedures appear in Section 6.2.
Frequency and range of detections, average detected concentrations, and number of screening concentration exceedances appear in Tables 10.13.2, 10.13.6, and 10.13.9.

a - Calculated soil-to-groundwater SSL value (See Table 6.2)
c - Carcinogenic
GW - Groundwater

NA - Not applicable/not available
ND - Not detected
RBC - Risk-based concentration
SSL - Soil screening level

NG/KG - Nanograms per kilogram
μG/KG - Micrograms per kilogram
PG/L - Picograms per liter
μG/L - Micrograms per liter

Table 10.13.13
Inorganic Chemicals Detected in Surface Soil, Subsurface Soil, Sediment, and Shallow Groundwater
Comparison to Cross-Media SSLs, Tap-Water RBCs, Saltwater Surface Water Chronic Screening Levels, and Background Values
Dredged Materials Area
Charleston Naval Complex
Charleston, South Carolina

Parameter	Maximum Concentration				Screening Concentration											
	Surface Soil	Subsurface Soil	Sediment	Surface Water	Soil to GW SSL	Soil Background	Soil to Air SSL	Tap Water RBC	Shallow GW Background	Saltwater Surf. Wtr Chronic	Soil Units	Water Units	Leaching Potential	Fugitive Particulate Inhalation Concern	Ground-water Migration Concern	Surface Water Migration Concern
Inorganic Chemicals																
Aluminum (Al)	39400	33200	39500	15700	560000 a	27400	NA	37000	1440	NA	MG/KG	µG/L	NO	NO	NO	NO
Antimony (Sb)	0.44	0.33	ND	ND	2.7	ND	NA	15	NA	NA	MG/KG	µG/L	NO	NO	NO	NO
Arsenic (As) c	14.8	21.3	16.7	26.3	15	21.6	750	0.045	23	36	MG/KG	µG/L	YES	NO	YES	NO
Barium (Ba)	48.4	41.2	45.5	53.2	820	54.2	690000	2600	110	NA	MG/KG	µG/L	NO	NO	NO	NO
Beryllium (Be)	1.3	1.2	1.4	ND	32	0.95	1300	73	1.1	NA	MG/KG	µG/L	NO	NO	NO	NO
Cadmium (Cd)	1.19	0.55	0.2	0.905	4	0.61	1800	18	NA	9.3	MG/KG	µG/L	NO	NO	NO	NO
Chromium (Cr) (total)	69	57.6	84.7	26.6	19	51.3	270	180	14.3	50	MG/KG	µG/L	YES	NO	NO	NO
Chromium (Cr6) (hexavalent)	0.628	ND	ND	ND	19	ND	270	180	ND	50	MG/KG	µG/L	NO	NO	NO	NO
Cobalt (Co)	7.9	7.7	10.5	3.65	990 a	5.8	NA	2200	2.2	NA	MG/KG	µG/L	NO	NO	NO	NO
Copper (Cu)	31.1	29.1	54.1	18.4	5600 a	240	NA	1500	4.4	2.9	MG/KG	µG/L	NO	NO	NO	YES
Lead (Pb)	31.2	28.3	38.8	36.1	400	203	400	15	4.4	8.5	MG/KG	µG/L	NO	NO	YES	YES
Manganese (Mn)	475	815	610	3540	480 a	419	NA	730	5430	NA	MG/KG	µG/L	YES	NO	NO	NO
Mercury (Hg)	0.24	0.24	ND	ND	1	0.47	10	11	NA	0.025	MG/KG	µG/L	NO	NO	NO	NO
Nickel (Ni)	19.8	15.8	22.3	10.6	65	23.9	13000	730	13.3	8.3	MG/KG	µG/L	NO	NO	NO	YES
Selenium (Se)	2.1	2.2	2.7	6.9	2.6	1.77	NA	180	ND	71	MG/KG	µG/L	NO	NO	NO	NO
Tin (Sn)	2	ND	ND	ND	5500 a	7.5	NA	22000	NA	NA	MG/KG	µG/L	NO	NO	NO	NO
Vanadium (V)	75.5	66.2	73.5	34.6	3000	113	NA	260	14	NA	MG/KG	µG/L	NO	NO	NO	NO
Zinc (Zn)	92.5	93.8	136	96.7	6200	206	NA	11000	24.4	86	MG/KG	µG/L	NO	NO	NO	YES

Notes:
Sources of screening concentrations appear in Table 5.6
Explanations of fate and transport screening procedures appear in Section 6.2.
Frequency and range of detections, average detected concentrations, and number of screening concentration exceedances appear in Tables 10.13.3, 10.13.7, and 10.13.10.

Background values for soil are shown for comparison purposes only.
Maximum groundwater concentrations are screened against the greater of tap water RBCs or corresponding background values to determine groundwater migration concern.

a - Calculated soil-to-groundwater SSL value (See Table 6.2)
c - Carcinogenic
GW - Groundwater

NA - Not available/Not applicable
ND - Not detected
RBC - Risk-based concentration

SSL - Soil screening level
MG/KG - Milligrams per kilogram
µG/L - Micrograms per liter

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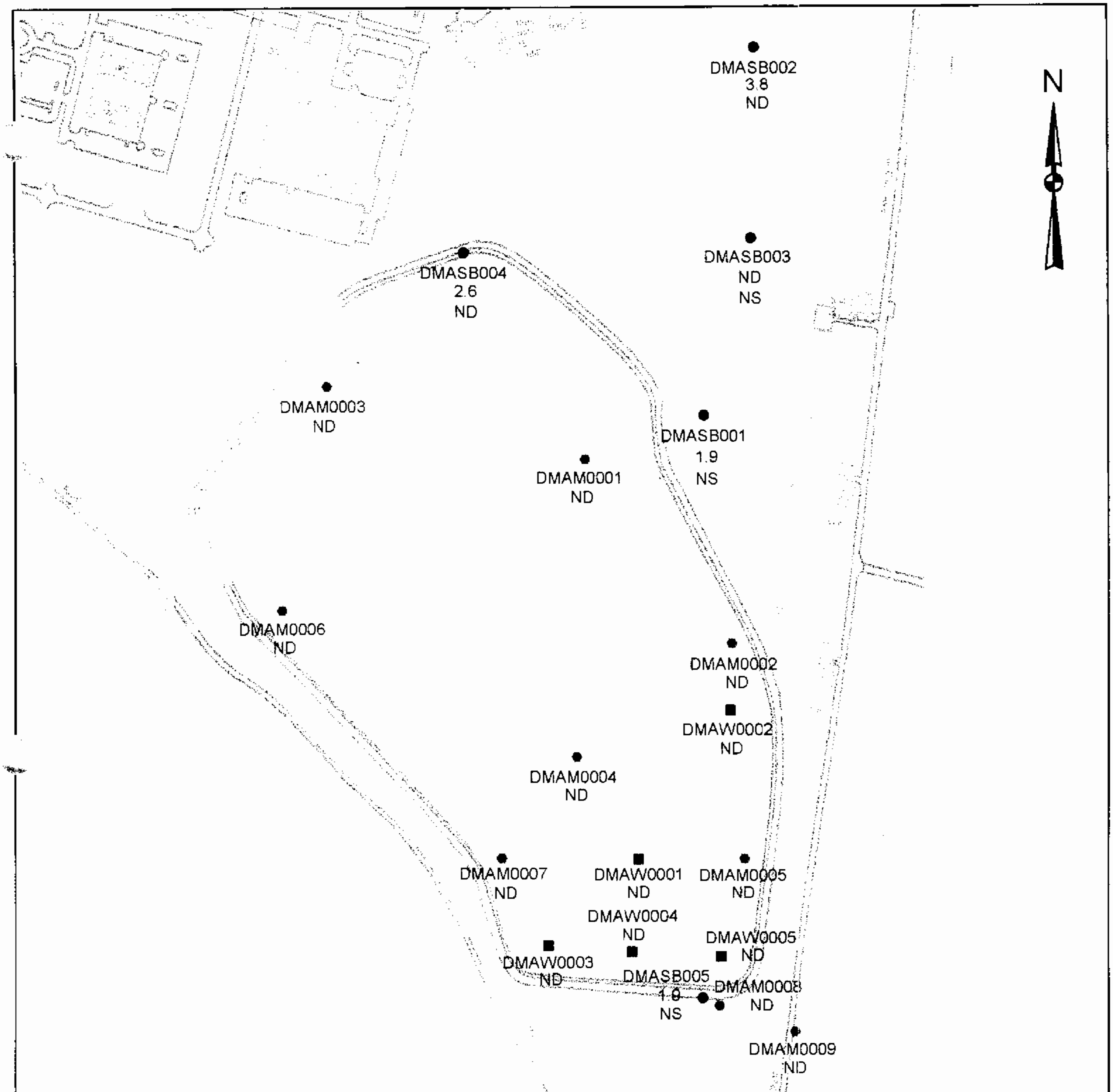


LEGEND

■	MONITORING WELL LOCATION
●	ZONE I SOIL BORING LOCATION
12.30	ZONE I SURFACE SOIL CONC. (UG/KG)
12.30	ZONE I SUBSURFACE SOIL CONC. (UG/KG)
12.30	MAXIMUM QUARTERLY GW CONC. (UG/L)
NS	NO SAMPLE TAKEN
ND	NON DETECT

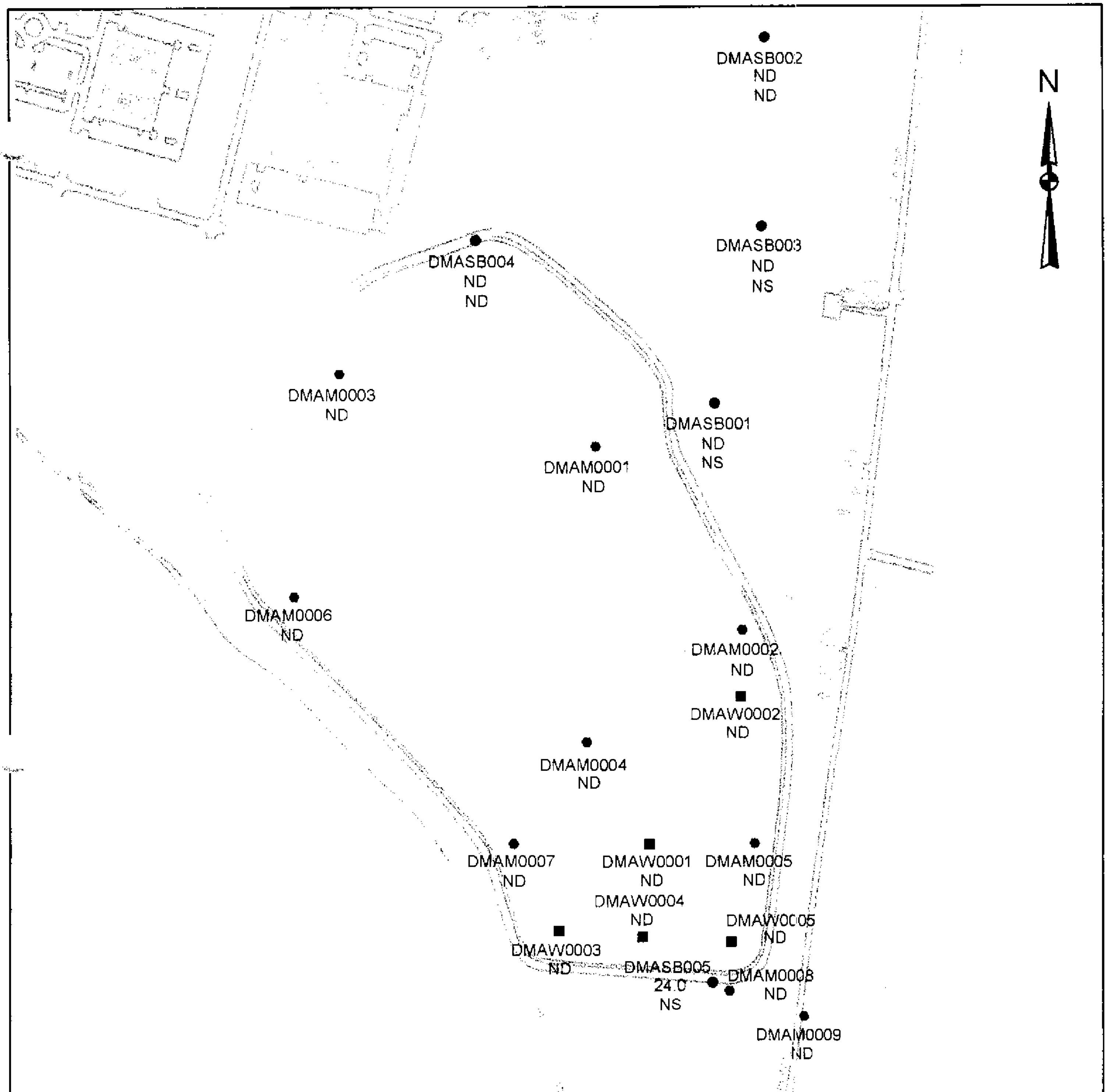
SCALE

200 0 200 400 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.13.2
ZONE I
DMA
BETA-BHC
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=NA RBC=350 UG/KG SSL=1.3 UG/KG



LEGEND

■ MONITORING WELL LOCATION
● ZONE I SOIL BORING LOCATION
12.30 ZONE I SURFACE SOIL CONC. (UG/KG)
12.30 ZONE I SUBSURFACE SOIL CONC. (UG/KG)
12.30 MAXIMUM QUARTERLY GW CONC. (UG/L)
NS NO SAMPLE TAKEN
ND NON DETECT

SCALE
200 0 200 400 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.13.3
ZONE I
DMA
DELTA-BHC
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=NA RBC=350 UG/KG SSL=1.8 UG/KG

Three inorganic parameters - arsenic, chromium and manganese - exceeded their SSLs in soil. Arsenic was below its SSL in surface soil, but exceeded its SSL in one subsurface sample. Figure 10.13.4 presents arsenic concentrations detected at the DMA. This exceedance was slight, suggesting that the pathway may not be significant for this parameter. Chromium was detected in all samples, and exceeded the SSL in three of five surface samples and both subsurface samples. Figure 10.13.5 presents chromium concentrations detected at the DMA. Like chromium, manganese was detected in all samples, but exceeded the SSL and zone-specific background in only one surface and one subsurface soil sample. Figure 10.13.6 presents manganese concentrations detected at the DMA. Both constituents are commonly detected in zone soil at similar concentrations, thus the site is not likely their source. Because no past site activities are expected to have created a metals enrichment, it is more likely that they are naturally occurring. The concentrations higher than background can be justified because this media was directly exposed to seawater in the past, which may have caused some secondary enrichment. At any rate, the soil-to-groundwater pathway is valid.

10.13.9.2 Soil-to-Sediment Cross-Media Transport

There were notable differences in the constituents detected in soil and the sediment samples. Several organics present in soil were absent in sediment, and the reverse is true, as well. Additionally, several inorganic parameters were present in sediment at levels higher than those in soil. These data suggest that the sediment is from a different source or was subjected to a different chemical environment (e.g., subaqueous exposure).

10.13.9.3 Soil-to-Air Transport

No VOCs were detected in surface soil above appropriate volatilization SSLs at this site; thus, this pathway is considered invalid.

10.13.9.4 DMA Fate and Transport Summary

Soil-to-Groundwater Pathway

Organics

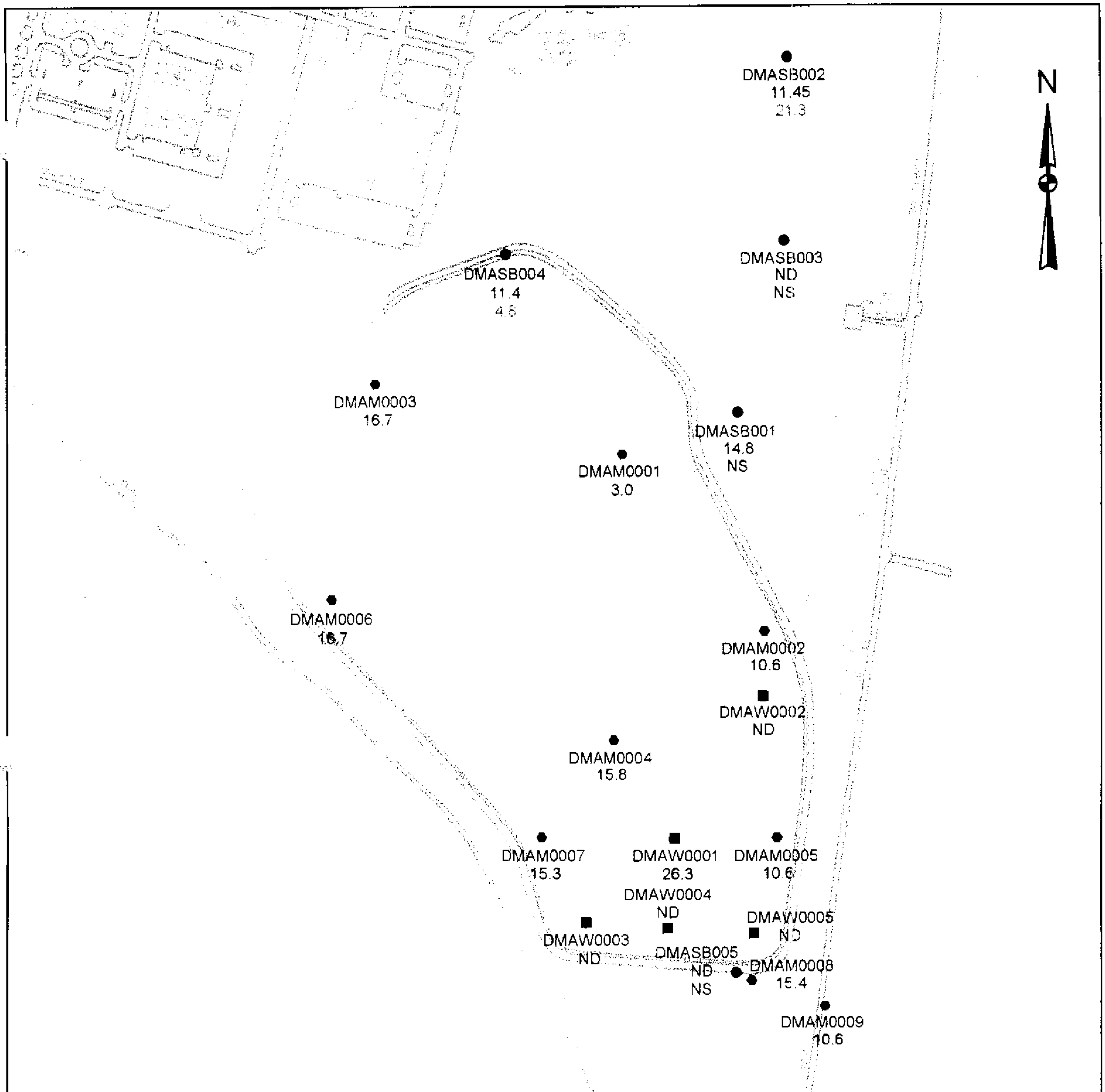
Two organic parameters - beta-BHC and delta-BHC - exceeded their SSLs in soil.

- Beta BHC exceeded its SSL in four of five surface samples, but was nondetect in subsurface samples. Delta BHC exceeded its SSL in only one of five surface samples, and was nondetect in subsurface samples.
- Several surface locations that exhibited exceedances were not sampled in the subsurface due to a high water table; thus, the pathway is considered valid for these pesticides.

Inorganics

Three inorganic parameters - arsenic, chromium and manganese - exceeded their SSLs.

- Arsenic exceeded its SSL in only one subsurface sample. Soil-to-groundwater pathway is considered valid, although it is unlikely to be significant due to the low concentration in soil.
- Chromium was detected in all samples, and exceeded the SSL in three of five surface samples and both subsurface samples.
- Manganese was also present in all samples, but exceeded the SSL and background in only one surface and one subsurface sample.
- These constituents are common in Zone I soils, and their presence and distribution on this site do not indicate the past site activities as their source, and it is likely that they are present naturally. However, the pathway is considered valid.



LEGEND

- ■ MONITORING WELL LOCATION
- ● ZONE I SOIL BORING LOCATION
- 12.30 ZONE I SURFACE SOIL CONC. (MG/KG)
- 12.30 ZONE I SUBSURFACE SOIL CONC. (MG/KG)
- *12.30* MAXIMUM QUARTERLY GW CONC. (UG/L)
- NS NO SAMPLE TAKEN
- ND NON DETECT

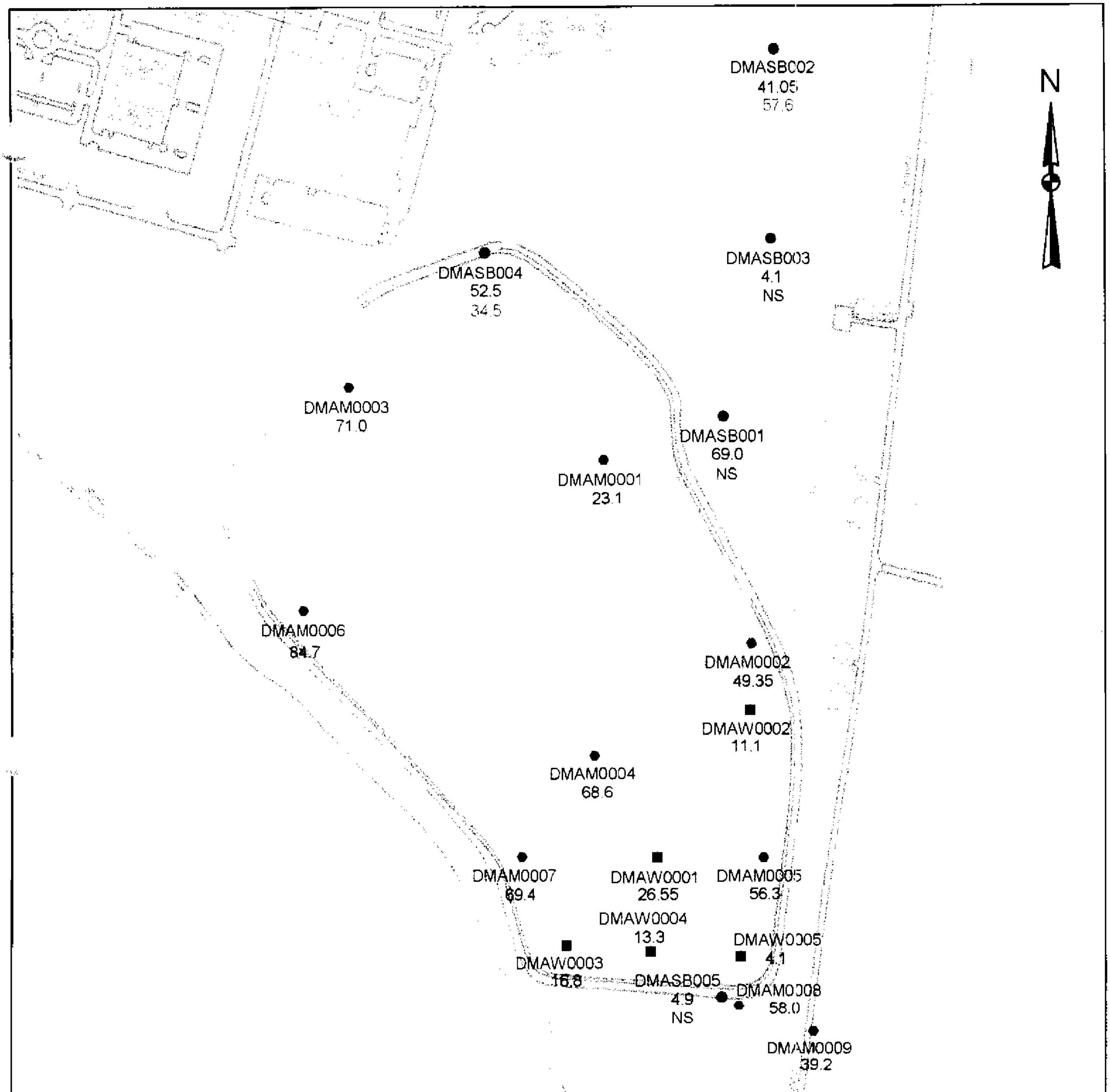
SCALE

200 0 200 400 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.13.4
ZONE I
DMA
ARSENIC
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=50 UG/L RBC=.43 MG/KG SSL=15 MG/KG



LEGEND

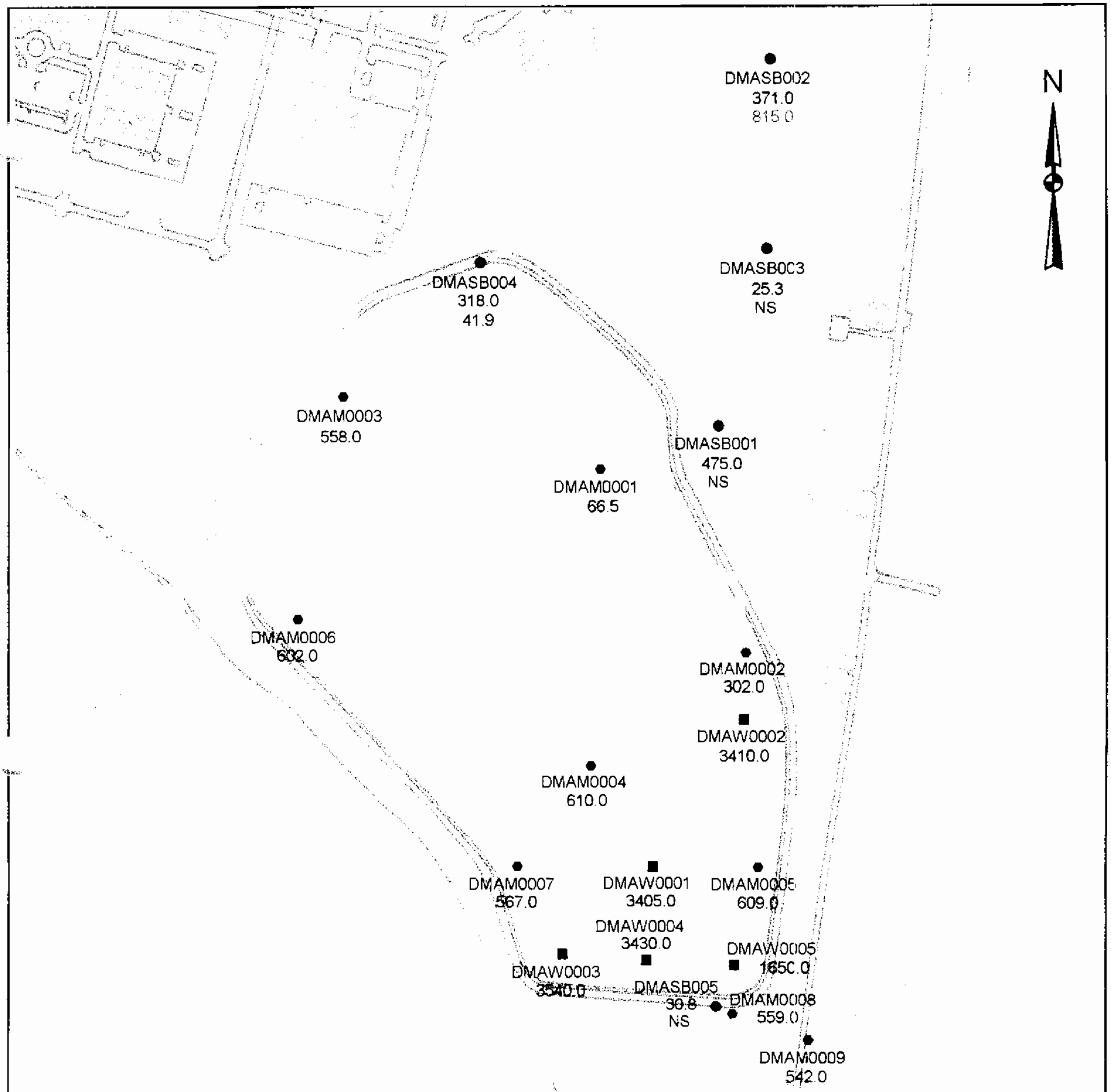
■ MONITORING WELL LOCATION
● ZONE I SOIL BORING LOCATION
12.30 ZONE I SURFACE SOIL CONC. (MG/KG)
12.30 ZONE I SUBSURFACE SOIL CONC. (MG/KG)
12.30 MAXIMUM QUARTERLY GW CONC. (UG/L)
NS NO SAMPLE TAKEN
ND NON DETECT

SCALE
200 0 200 400 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.13.5
ZONE I
DMA
CHROMIUM
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=100 UG/L RBC=39 MG/KG SSL=19 MG/KG



LEGEND

■	MONITORING WELL LOCATION
●	ZONE I SOIL BORING LOCATION
12.30	ZONE I SURFACE SOIL CONC. (MG/KG)
12.30	ZONE I SUBSURFACE SOIL CONC. (MG/KG)
12.30	MAXIMUM QUARTERLY GW CONC. (UG/L)
NS	NO SAMPLE TAKEN
ND	NON DETECT

SCALE

200 0 200 400 Feet

ZONE I - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.13.6
ZONE I
DMA
MANGANESE
ZONE I EXCEEDANCES
SOIL AND GW CONCENTRATIONS

MCL=NA RBC=160 MG/KG SSL=480 MG/KG

Soil-to-Sediment Pathway

Constituents in site soil were notably different from those in sediment. Several were specific to one media, and some inorganics were higher in sediment than soil. These data suggest that the sediment is from another source, or has been subjected to a different chemical environment.

Soil-to-Air Pathway

No VOCs exceeded volatilization screening values; thus, the pathway is considered invalid for this AOC.

10.13.10 Human Health Risk Assessment

10.13.10.1 Site Background and Investigative Approach

The Dredge Materials Area was investigated to assess soil, surface water and sediment quality at this Clean Water Act Section 404 permitted dredge spoil disposal area. The dredged materials disposed of at the DMA are produced during periodic channel clearing operations in Cooper River and Shipyard Creek. In the Zone I work plan, the DMA was not specifically identified as a SWMU or AOC.

Five soil samples were collected from the upper-interval, five surface water samples were collected from areas standing water was standing, and nine sediment samples were collected from the DMA. Sections 10.13.1, 10.13.3, and 10.13.5 provided information regarding the scope of the sampling activities conducted for the DMA. No groundwater was sampled in conjunction with the DMA investigation.

10.13.10.2 COPC Identification

Soil

Based on the screening comparisons described in Section 7 of this RFI and presented in Table 10.13.14, aluminum and chromium were identified as soil COPCs for the DMA.

Table 10.13.14
Chemicals Present in Site Samples
Dredged Materials Area - Surface Water
Charleston Naval Complex
Charleston, South Carolina

Parameter	Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration AWQC	Reference	Units
Inorganics										
Aluminum (Al)	5	5	364	15700	7461	NA	NA	NA	NA	µg/L
Arsenic (As) *	1	5	26.3	26.3	26.3	13.3	20.4	1.4	NA	µg/L
Barium (Ba)	5	5	25.8	53.15	43.9	NA	NA	NA	NA	µg/L
Cadmium (Cd)	1	5	0.91	0.91	0.91	0.3	0.3	10	NA	µg/L
Calcium (Ca)	5	5	236000	298000	279400	NA	NA	NA	NA	µg/L
Chromium (Cr)	5	5	4.1	26.55	14.4	NA	NA	50	NA	µg/L
Cobalt (Co)	4	5	1.5	3.65	2.2	0.6	0.6	NA	NA	µg/L
Copper (Cu)	5	5	4.8	18.35	11.6	NA	NA	NA	NA	µg/L
Iron (Fe)	5	5	2020	13500	7702	NA	NA	NA	NA	µg/L
Lead (Pb)	5	5	4.3	36.05	13.4	NA	NA	50	NA	µg/L
Magnesium (Mg)	5	5	237000	352000	326200	NA	NA	NA	NA	µg/L
Manganese (Mn)	5	5	1650	3540	3087	NA	NA	NA	NA	µg/L
Nickel (Ni)	5	5	2.9	10.6	6.7	NA	NA	4584	NA	µg/L
Potassium (K)	5	5	99500	177500	156600	NA	NA	NA	NA	µg/L
Selenium (Se)	5	5	5	6.9	6.1	NA	NA	10	NA	µg/L
Sodium (Na)	5	5	1500000	2525000	2269000	NA	NA	NA	NA	µg/L
Vanadium (V)	5	5	4.7	34.6	18.9	NA	NA	NA	NA	µg/L
Zinc (Zn)	5	5	27.8	96.7	55.8	NA	NA	NA	NA	µg/L
Semivolatiles										
Phenol	1	5	19.5	19.5	19.5	15	15	3500	NA	µg/L
Volatiles										
Acetone	2	5	6	12	9.0	15	15	NA	NA	µg/L

Notes:
* - Indicates chemical was identified as a COPC
SQL - Sample quantitation limit
AWQC - Ambient water quality criteria for the protection of human health
µg/L - [illegible]rograms per liter
NA - [illegible] applicable or not available

Sediment

Based on the screening comparisons presented in Table 10.13.15, aluminum and chromium were also identified as sediment COPCs for the DMA. Sediment analytical results were compared to residential soil RBCs and soil reference concentrations.

Surface Water

Surface water results were preliminarily screened using ambient water quality criteria (AWQC) for the protection of human health as provided in the *Water Classifications and Standards (Regulation 61-68)* (SCDHEC, 1992). As shown in Table 10.13.16, arsenic exceeded its AWQC in the only surface water sample in which it was detected. No reference surface water concentrations have been derived for Zone I or other areas along the southern tip of the base. Arsenic concentrations were not elevated significantly higher than could be expected in unaffected natural surface water. Soil and sediment results for the DMA do not indicate a non-natural source for arsenic. Furthermore, the AWQCs against which the surface water data were screened assume recreational and potable water uses. These uses are not anticipated for the surface water that collects inside the DMA. Based on these factors, no formal quantitative risk assessment was warranted relative to DMA surface water.

10.13.10.3 Exposure Assessment

Potentially Exposed Populations

Potentially exposed populations are current and future site workers, hypothetical future site residents, and adolescent trespassers. Future site resident and worker exposure scenarios were

Table 10.13.15
Chemicals Present in Site Samples
Dredged Materials Area - Sediment
Charleston Naval Complex
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration Residential RBC	Reference	Units
Inorganics											
Aluminum (Al)	*	9	9	6010	39500	26612	NA	NA	7800	27400	mg/kg
Arsenic (As)		9	9	3	16.7	12.7	NA	NA	0.43	21.6	mg/kg
Barium (Ba)		9	9	12.7	45.5	33.6	NA	NA	550	54.2	mg/kg
Beryllium (Be)		9	9	0.33	1.4	1.0	NA	NA	16	0.95	mg/kg
Cadmium (Cd)		1	9	0.2	0.2	0.20	0.06	0.35	7.8	0.61	mg/kg
Calcium (Ca)	N	9	9	9825	53600	28081	NA	NA	NA	NA	mg/kg
Chromium (Cr)	*	9	9	23.1	84.7	57.7	NA	NA	39	34.5	mg/kg
Cobalt (Co)		9	9	2.1	10.5	7.4	NA	NA	470	5.8	mg/kg
Copper (Cu)		9	9	6.3	54.1	31.8	NA	NA	310	240	mg/kg
Iron (Fe)	N	9	9	5970	33500	24908	NA	NA	NA	NA	mg/kg
Lead (Pb)		9	9	7	38.8	25.0	NA	NA	400	203	mg/kg
Magnesium (Mg)	N	9	9	2950	9460	6222	NA	NA	NA	NA	mg/kg
Manganese (Mn)		9	9	66.5	610	491	NA	NA	1100	419	mg/kg
Nickel (Ni)		9	9	7.5	22.3	15.5	NA	NA	160	23.9	mg/kg
Potassium (K)	N	9	9	1220	4630	3144	NA	NA	NA	NA	mg/kg
Selenium (Se)		9	9	1	2.7	1.8	NA	NA	39	1.49	mg/kg
Sodium (Na)	N	9	9	2720	14200	7867	NA	NA	NA	NA	mg/kg
Vanadium (V)		9	9	14.3	73.5	50.5	NA	NA	55	113	mg/kg
Zinc (Zn)		9	9	25.2	136	89.7	NA	NA	2300	206	mg/kg
Organotins											
Dibutyltin		1	9	8.7	8.7	8.7	4.2	10.2	2300	NA	µg/kg
Monobutyltin		1	9	4.5	4.5	4.5	4.2	10.2	2300	NA	µg/kg
Tetrabutyltin		2	9	49.8	87	68.4	4.2	10.2	2300	NA	µg/kg
Tributyltin		7	9	12.2	71.4	26.8	4.2	10.2	2300	NA	µg/kg

Table 10.13.15
Chemicals Present in Site Samples
Dredged Materials Area - Sediment
Charleston Naval Complex
Charleston, South Carolina

Parameter	Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration Residential RBC	Reference	Units
OC Pesticides										
4,4'-DDD	1	9	31	31	31.0	5	4700	2700	NA	µg/kg
4,4'-DDE	1	9	34	34	34.0	5	4700	1900	NA	µg/kg
Endrin aldehyde	1	9	67	67	67.0	1.4	1300	2300	NA	µg/kg
Semivolatiles										
Benzo(a)pyrene equivalvents	3	9	21.31	29.83	26.7	940	2100	88	NA	µg/kg
Fluoranthene	5	9	94	250	171	1300	1900	310000	NA	µg/kg
Pyrene	6	9	79	340	180	1000	1300	230000	NA	µg/kg
Volatiles										
Acetone	3	9	28	46	37.3	60	290	780000	NA	µg/kg

Notes:
* - Indicates chemical was identified as a COPC
N - Indicates chemical is an essential nutrient
SQL - Sample quantitation limit
RBC - Risk-based concentration
µg/kg - micrograms per kilogram
mg/kg - milligrams per kilogram
NA - Not applicable or not available
ND - Not determined due to lack of information

Table 10.13.16
Statistical Analysis of COPCs
Surface Soil and Sediment - Dredged Materials Area
Charleston Naval Complex
Charleston, South Carolina

COPC	Natural Log Transformed n	mean	SD	H-stat	UCL (mg/kg)	MAX (mg/kg)	EPC (mg/kg)
Aluminum	14	9.630	1.300	3.332	117756	39500	39500 MAX
Chromium	14	3.634	0.961	2.738	125	84.7	84.7 MAX

Notes:

mean arithmetic mean of the logtransformed data

n number of samples analyzed

SD standard deviation for a sample of data

H-stat "H" statistic from Gilbert 1987; cuboidal interpolation was used to determine the value in accordance with *USEPA Supplemental Guidance to RAGS, Calculating the Concentration Term.*

EPC exposure point concentration

UCL 95 percentile upper confidence level mean

MAX maximum reported concentration

mg/kg milligrams per kilgram

addressed quantitatively in this risk assessment. Current exposure to workers is discussed quantitatively in relation to the future workers and future residents. The hypothetical future site worker scenario assumed continuous exposure to surface soil conditions. Current site workers' exposure would be less than that assumed for the hypothetical future site worker scenario because of their limited soil contact. Therefore, future worker assessment is considered to be conservatively representative of current site workers. The resident child scenario was considered to be conservatively representative of the adolescent trespasser. The future site resident scenario was built on the premise that existing features would be removed and replaced with dwellings. All receptors were assumed to be exposed to sediment through the same pathways as soil.

Exposure Pathways

Exposure pathways for the hypothetical future site residents are dermal contact and incidental ingestion of surface soils. The exposure pathways for future site workers are the same as those for the future site resident with respect to soil. In addition, the hypothetical future site worker scenario assumed continuous exposure to surface soil conditions. Uniform exposure was assumed for all sample locations. Table 10.13.17 presents the justification for exposure pathways assessed in this HHRA.

Exposure Point Concentrations

As discussed in Section 7 of this RFI, UCLs were calculated for data sets consisting of at least 10 samples. UCLs were calculated for surface soil and sediment COPCs at the DMA as presented in Table 10.13.18. Because the UCLs exceeded the maximum concentrations, the maximum concentrations were applied as EPCs for aluminum and chromium.

Quantification of Exposure

CDIs for ingestion and dermal contact with soils are shown in Tables 10.13.19 and 10.13.20, respectively.

Table 10.13.17
Exposure Pathways Summary
DMA

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Current Land Uses			
Current Users (Site Workers)	Air, Inhalation of gaseous contaminants emanating from soil and sediment	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	This exposure pathway was considered insignificant compared to the other pathways.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Shallow groundwater is not currently used as a source of potable or non-residential water at AOC 685.
	Shallow groundwater, Inhalation of volatilized groundwater contaminants	No	Shallow groundwater is not currently used as a source of potable or non-residential water at AOC 685.
	Soil and Sediment, Incidental ingestion	No (Qualified)	Future site use is considered conservatively representative of current receptors.
	Soil and Sediment, Dermal contact	No (Qualified)	Future site use is considered conservatively representative of current receptors.
Future Land Uses			
Future Site Residents (Child and Adult), Future Site Worker	Air, Inhalation of gaseous contaminants emanating from soil and sediment	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	This exposure pathway was considered insignificant compared to the other pathways.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Shallow groundwater, Inhalation of volatilized contaminants during domestic use	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Soil and Sediment, Incidental ingestion	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.
	Soil and Sediment, Dermal contact	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.
	Wild game or domestic animals, Ingestion of tissue impacted by media contamination	No	Hunting/taking of game and/or raising livestock is prohibited within the Charleston, South Carolina, city limits.
	Fruits and vegetables, Ingestion of plant tissues grown in media	No	The potential for significant exposure via this pathway is low relative to that of other exposure pathways assessed.

Table 10.13.18
Chronic Daily Intakes
Incidental Ingestion of Surface Soil and Sediment
Dredge Materials Area
Charleston Naval Complex
Charleston, South Carolina

Chemical	Exposure Point Concentration (mg/kg)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident LWA C-CDI (mg/kg-day)	Future Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Aluminum	39500	5.41E-02	5.05E-01	6.18E-02	1.93E-02	6.90E-03
Chromium	84.7	1.16E-04	1.08E-03	1.33E-04	4.14E-05	1.48E-05

Notes:
LWA Lifetime weighted average; used to calculate carcinogenic CDI, *RAGS Parts A and B*.
CDI Chronic daily intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk

Table 10.13.19
Chronic Daily Intakes
Dermal Contact with Surface Soil and Sediment
Dredge Materials Area
Charleston Naval Complex
Charleston, South Carolina

Chemical	Exposure Point Concentration (mg/kg)	Dermal Absorption Factor+ (unitless)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident LWA C-CDI (mg/kg-day)	Future Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Aluminum	39500	0.001	2.22E-03	7.32E-03	1.39E-03	1.58E-03	5.66E-04
Chromium	84.7	0.001	4.76E-06	1.57E-05	2.98E-06	3.40E-06	1.21E-06

Notes:

CDI Chronic daily intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
* The dermal absorption factor was applied to the exposure point concentration to reflect the different transdermal migration of inorganic versus organic chemicals.

Table 10.13.20
Toxicological Reference Information
for Chemicals of Potential Concern
Dredged Materials Area
Charleston Naval Complex
Charleston, South Carolina

	Non-Carcinogenic Toxicity Data									*Carcinogenic Toxicity Data*					
Chemical	Oral Reference Dose (mg/kg-day)		Confidence Level	Critical Effect	Uncertainty Factor Oral	Inhalation Reference Dose (mg/kg-day)		Confidence Level	Critical Effect	Uncertainty Factor Inhalation	Oral Slope Factor (kg-day/mg)	Inhalation Slope Factor (kg-day/mg)		Weight of Evidence	Tumor Type
Aluminum	1	c	NA	NA	NA	NA		NA	NA	NA	NA	NA		NA	NA
Chromium III	1	a	L	NA	100/10	NA		NA	NA	NA	NA	NA	a	D	NA
Chromium VI	0.005	a	L	NA	500	1E-07	c	NA	NA	NA	NA	41	a	A	lung

Notes:

a = Integrated Risk Information System (IRIS)
c = EPA NCEA - Cincinnati (provisional)
NA = Not applicable or not available

10.13.10.4 Toxicity Assessment

Toxicity assessment terms and methods are discussed in Section 7 of this report. Table 10.13.21 presents toxicological information specific to each COPC identified at the DMA. This information was used in the quantification of risk/hazard associated with soil contaminants. Brief toxicological profiles for each COPC are provided in the following paragraphs.

Aluminum is one of the most abundant metals in the earth's crust (7% aluminum), and it is ubiquitous in air and water, as well as soil. This metal is water-soluble, silvery, and ductile, which suggests its usefulness in many processes. Ingesting aluminum can affect the absorption of other elements within the gastrointestinal tract and can alter intestinal function. Aluminum may interfere with the absorption of essential nutrients and cholesterol. Another effect on the gastrointestinal system is the inhibition of acetylcholine-induced contractions, which are part of the neuro-muscular system controlling bowel muscles. (The effect could explain why aluminum-containing antacids often produce constipation and indicates that aluminum could affect the uptake of other chemicals.) Aluminum dust is moderately flammable and explosive in heat. Inhaling this dust can cause fibrosis (aluminosis) (Klaasen, et al., 1986; Dreisbach, et al., 1987). No data are available on an applicable SF or the USEPA cancer group. The USEPA Region IV Office of Health Assessment suggested using the provisional oral RfD of 1.0 mg/kg-day. The aesthetic-based secondary MCL (SMCL) for drinking water is 50 to 200 μg/L.

Chromium exists in two stable, natural forms: CrIII and hexavalent CrVI. Acute exposure to chromium can result in kidney damage following oral exposure or damage to the nasal mucosa and septum following inhalation exposure. Chronic inhalation exposure to CrVI has resulted in kidney and respiratory tract damage, as well as excess lung cancer in both animals and humans following occupational exposure. Only CrVI is thought be carcinogenic by inhalation (IRIS). Oral RfD values for CrIII and CrVI are 1.0 and 5E-03 (mg/kg-day), respectively. For CrVI, the RfD is based on liver toxicity in rats. For CrVI, the RfD is based on unspecified pathological changes

Table 10.13.21
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil and Sediment Ingestion
Dredged Materials Area
Charleston Naval Complex
Charleston, South Carolina

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used $(mg/kg\text{-}day)^{-1}$	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident LWA ILCR	Future Worker adult Hazard Quotient	Future Worker adult ILCR
Aluminum	1	NA	0.054	0.51	ND	0.019	ND
Chromium	0.005	NA	0.023	0.22	ND	0.0083	ND
SUM Hazard Index/ILCR			0.08	0.7	ND	0.03	ND

Notes:
NA Not available
ND Not determined due to lack of available information
LWA Lifetime-weighted average; used to calculate excess carcinogenic risk derived from *RAGS Part A*.
ILCR Incremental lifetime excess cancer risk

observed in rat studies. In addition, CrVI is considered a group A carcinogen for inhalation exposures, and an inhalation SF of 41 $(mg/kg\text{-}day)^{-1}$ has been established for the hexavalent form. Vitamin supplements contain approximately 0.025 mg of chromium. As listed in IRIS, no critical effects were observed for CrIII. The uncertainty factor was 100 and the modifying factor was 10. As listed in IRIS, no critical effects were observed for CrVI. The uncertainty factor was 500 and the modifying factor was 1.

10.13.10.5 Risk Characterization

Surface Soil Pathways

Exposure to surface soil and sediment onsite was evaluated under both future residential and industrial (site worker) scenarios. For these scenarios, the incidental ingestion and dermal contact exposure pathways were evaluated. For noncarcinogenic contaminants evaluated for future site residents, hazard was computed separately to address child and adult exposure. Tables 10.13.22 and 10.13.23 present the computed carcinogenic risks and/or HQs associated with the incidental ingestion of and dermal contact with site surface soils, respectively.

Hypothetical Site Residents

The computed hazard indices for the adult and child resident were 0.08 and 0.7, respectively, for the soil ingestion pathway. The dermal contact pathway hazard indices were 0.02 and 0.05 for the adult resident and the child resident, respectively.

Future Site Workers

The hazard indices for both pathways were less than 0.1 for the site worker.

COCs Identified

USEPA has established a generally acceptable risk range of 1E-04 to 1E-06, and a hazard index threshold of 1.0 (unity). As recommended by SCDHEC, a COC was considered to be any chemical contributing to a cumulative risk level of 1E-06 or greater and/or a cumulative hazard

Table 10.13.22
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil and Sediment
Dredge Materials Area
Charleston Naval Complex
Charleston, South Carolina

Chemical	Dermal Adjustment*	Oral RfD Used (mg/kg-day)	Oral SF Used $(mg/kg\text{-}day)^{-1}$	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident LWA ILCR	Future Worker adult Hazard Quotient	Future Worker adult ILCR
Aluminum	0.2	0.2	NA	0.011	0.037	ND	0.0079	ND
Chromium	0.2	0.001	NA	0.0048	0.016	ND	0.0034	ND
SUM Hazard Index/ILCR				0.02	0.05	ND	0.01	ND

Notes:
NA Not available
ND Not determined due to lack of available information
LWA Lifetime-weighted average; used to calculate excess carcinogenic risk derived from *RAGS Part A.*
ILCR Incremental lifetime excess cancer risk
* Dermal to absorbed dose adjustment factor is applied to adjust for oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI).

Table 10.13.23
Summary of Risk and Hazard-based COCs for Dredged Materials Area
Charleston Naval Complex
Charleston, South Carolina

Medium	Exposure Pathway		Future Resident Adult Hazard Quotien	Future Resident Child Hazard Quotien	Future Resident LWA ILCR	Future Site Worker Hazard Quotien	Future Site Worker ILCR
Surface Soil	Incidental	Aluminum	0.054	0.51	ND	0.019	ND
	Ingestion	Chromium	0.023	0.22	ND	0.0083	ND
	Dermal Contact	Aluminum	0.011	0.037	ND	0.0079	ND
		Chromium	0.0048	0.016	ND	0.0034	ND
Surface Soil Pathway Sum			0.09	0.8	ND	0.04	ND

Notes:
ND = not determined due to the lack of available risk information.
ILCR = incremental excess lifetime cancer risk
HI = hazard index
LWA = Lifetime-weighted average
1- Chemical is a COC by virtue of projected child residence non-carcinogenic hazard.
2- Chemical is a COC by virtue of projected future resident lifetime ILCR.
3- Chemical is a COC by virtue of projected site worker non-carcinogenic hazard.
4- Chemical is a COC by virtue of projected site worker ILCR.

index above 1.0, if its individual ILCR exceeds 1E-06 or its hazard quotient exceeds 0.1. For carcinogens, this approach is relatively conservative, because a cumulative risk level of 1E-04 (and individual ILCR of 1E-06 is recommended by USEPA Region IV as the trigger for establishing COCs. The COC selection algorithm presented was used to a more comprehensively evaluate chemicals contributing to carcinogenic risk or noncarcinogenic hazard during remedial goal development. As shown on Table 10.13.24, no COCs were identified at the DMA.

10.13.10.6 Risk Uncertainty

Characterization of Exposure Setting and Identification of Exposure Pathways

The potential for high bias is introduced through the exposure setting and pathway selection due to the highly conservative assumptions (i.e., future residential use) recommended by USEPA Region IV when assessing potential future and current exposure. The exposure assumptions made in the site worker scenario are highly conservative and would tend to overestimate exposure. Residential use of the site would not be expected, based on current site uses. Current reuse plans call for continued nonresidential use of Zone I. If this area were to be used as a residential site, surface soil conditions would likely change — the soils could be covered with landscaping soil and/or a house. Consequently, exposure to current surface soil conditions is possible under a future residential scenario. These factors indicate that exposure pathways assessed in this HHRA would generally overestimate the risk and hazard posed to current site workers and future site residents.

Determination of Exposure Point Concentrations

The exposure point concentration was set equal to the maximum detected concentration. Using the maximum concentrations as the EPCs represents a conservative assumption for calculation of the chronic daily intake of COPCs at the DMA.

Table10.13.24
Summary of Risk and Hazard for the Dredged Materials Area
Charleston Naval Complex,
Charleston, South Carolina

Medium	Exposure Pathway	HI (Adult)	HI (Child)	ILCR (LWA)	HI (Worker)	ILCR (Worker)
Surface Soil	Incidental Ingestion	0.08	0.7	ND	0.03	ND
	Dermal Contact	0.02	0.05	ND	0.01	ND
Sum of Soil Pathways		0.09	0.8	ND	0.04	ND

Notes:
ND = not determined due to the lack of available risk information.
ILCR = incremental excess lifetime cancer risk
HI = hazard index
LWA = Lifetime-weighted average

Quantification of Risk/Hazard

As indicated by the discussions above, the uncertainty inherent in the risk assessment process is great. In addition, many site-specific factors have affected the uncertainty of this assessment that would upwardly bias the risk and hazard estimates. Exposure pathway-specific sources of uncertainty are discussed below.

Of the CPSSs screened and eliminated from formal assessment, none was reported within approximately 10% of the RBC. This minimizes the likelihood of potentially significant cumulative risk/hazard based on the eliminated CPSSs. Although the future land use at this site is unknown, both the future worker and residential exposure scenarios were assessed in this HHRA. As previously discussed, these scenarios would likely lead to overestimates of risk and/or hazard.

10.13.10.7 Risk Summary

The risk and hazard posed by contaminants at the DMA were assessed for the hypothetical future site worker and the hypothetical future site resident under reasonable maximum exposure assumptions. For surface soils and sediment, the incidental ingestion and dermal contact pathways were assessed in this HHRA. No COCs were identified for this site. Table 10.13.23 presents the risk summary for each pathway/receptor group evaluated for the DMA.

10.13.11 Corrective Measures Considerations for Dredged Materials Area

Based on the analytical results and the human health risk assessment for the DMA, no COCs have been identified. Risk to human health from COPCs was evaluated for surface soils and sediment under both the future residential and industrial (site worker) scenarios for incidental ingestion and dermal contact. Hazard was evaluated for noncarcinogenic contaminants through incidental ingestion and dermal contact scenarios as well.

As recommended by SCDHEC, a COC is considered to be any chemical contributing to a cumulative risk level of 1E-06 or greater and/or a cumulative hazard index above 1.0. Based on these criteria, no chemical was identified as a soil or sediment pathway COCs for the DMA. Therefore, no further action is required based on the analytical results and risk assessment.

10.14 Grid-Based Sampling

To characterize background conditions across Zone I, as required by the *Final Zone I RFI Work Plan* (E/A&H, February 1995), systematic grid-based soil and groundwater sampling was performed. Usable data from those well pairs near AOCs or SWMUs were incorporated into the appropriate site-specific assessments if it appeared that the grid-based monitoring wells had been impacted by site activities. If the SWMU or AOC had no impact on its associated grid-based pair, the well pair was used to determine background levels used in the site-specific evaluations for soil and groundwater.

10.14.1 Soil Sampling and Analysis

The *Final Zone I RFI Work Plan* (E/A&H, February 1995) proposed 18 upper-interval soil samples and 18 lower-interval samples. Fifteen upper-interval and six lower-interval samples were collected. Three upper-interval samples were not collected due to standing in water at the proposed locations. Samples were collected from the locations shown on Figure 3.1 (Section 3). Lower-interval samples were not collected at 12 locations due to a water table less than 5 feet bgs; saturated samples were not submitted for analysis. Samples were collected for organotins and the standard suite of parameters, which includes VOCs, SVOCs, metals, cyanide, pesticides, and PCBs. Table 10.14.1 summarizes soil sampling and analysis of the grid-based locations.

Table 10.14.1
Grid-Based Sampling
Soil Sampling Summary

Sampling Round	Sampling Date	Samples Collected	Sample Analyses	Comments
1	02/16/95 02/17/95	Upper - 15 (18) Lower - 6 (18)	Standard Suite, Organotins	Surface water in sampling locations prevented collection of 3 upper-interval soil samples. Twelve lower-interval samples were not collected due to a water table at less than 5 feet bgs.
		Duplicate - 1	Appendix IX	

Notes:
( ) = Parentheses indicate number of samples proposed.
Standard Suite = VOCs, SVOCs, metals, cyanide, pesticides, and PCBs at DQO Level III.
Appendix IX = Standard suite, plus hex-chrome, dioxins, herbicides, and OP pesticides at DQO Level IV.

10.14.2 Nature and Extent of Chemicals in Soil

Organic compound analytical results for soil are summarized in Table 10.14.2. Inorganic analytical results for soil are summarized in Table 10.14.3. Table 10.14.4 summarizes all analytes detected in the grid based borings. Appendix D contains a complete analytical data report for all grid-based samples collected in Zone I.

Additionally, the following grid-based borings are discussed in the listed AOC and/or SWMU nature and extent of chemicals in soil subsection:

AOC/SWMU	Boring
675/676/677	GDISB015
678/679*	GDISB014
681*	GDISB013
685	GDISB010
687/16	GDISB008
689/690	GDISB002
177/RTC	GDISB016

* AOC 678/679 and AOC 681 discussions are not included in this RFI submittal but will be submitted as an addendum to this report.

Table 10.14.2
Grid-Based Locations
Organic Compound Analytical Results for Soil (μg/kg)

Parameter	Sampling Interval	Detection Frequency	Detection Range	Mean	RBC (upper) SSL (lower)	Number of Samples Exceeding RBC or SSL
Volatile Organic Compounds						
Acetone	Upper	5/15	22.0 - 62.0	48.2	780,000	0
	Lower	4/6	42.0 - 110	63.7	8,000	0
Toluene	Upper	7/15	2.0 - 40.0	8.28	1,600,000	0
	Lower	5/6	2.0 - 21.0	7.6	6,000	0
Semivolatile Organic Compounds						
1-Methylnaphthalene	Upper	1/15	99.0	99.0	310,000	0
	Lower	0/6	ND	ND	72,000	0
2-Methylnaphthalene	Upper	1/15	60.0	60.0	310,000	0
	Lower	0/6	ND	ND	230,000	0

Table 10.14.2
Grid-Based Locations
Organic Compound Analytical Results for Soil (μg/kg)

Parameter	Sampling Interval	Detection Frequency	Detection Range	Mean	RBC (upper) SSL (lower)	Number of Samples Exceeding RBC or SSL
Anthracene	Upper	0/18	ND	ND	2,300,000	0
	Lower	1/6	160	160	5,900,000	0
BEQ[b]	Upper	5/15	4.34 - 66.3	19.8	87	0
	Lower	1/6	78.4	78.4	1,600	0
Benzo(a)anthracene	Upper	2/15	43.0 - 59.0	51.0	87	0
	Lower	1/6	130	130	1,600	0
Benzo(a)pyrene	Upper	1/15	50.0	50.0	87	0
	Lower	1/6	52.0	52.0	4,000	0
Benzo(b)fluoranthene	Upper	4/15	81.0 - 97.0	89.5	870	0
	Lower	1/6	120	120	2,500	0
Benzo(k)fluoranthene	Upper	4/15	97.0 - 120	103	8,700	0
	Lower	1/6	130	130	25,000	0
Chrysene	Upper	2/15	40.0 - 49.0	44.5	87,000	0
	Lower	1/6	140	140	80,000	0
Benzoic acid	Upper	1/15	150	150	31,000,000	0
	Lower	0/6	ND	ND	200,000	0
bis(2-Ethylhexyl)phthalate	Upper	3/15	65.0 - 100	88.3	46,000	0
	Lower	0/6	ND	ND	1,800,000	0
Butylbenzylphthalate	Upper	1/15	98.0	98.0	1,600,000	0
	Lower	0/6	ND	ND	930,000	0
Di-n-butylphthalate	Upper	1/15	100	100	780,000	0
	Lower	2/6	82.0 - 130	106	2,300,000	0
Fluoranthene	Upper	3/15	79.0 - 81.0	80.0	310,000	0
	Lower	1/6	650	650	2,100,00	0
Phenanthrene	Upper	3/15	47.0 - 63.0	56.0	230,000	0
	Lower	0/6	ND	ND	660,000	0
Pyrene	Upper	4/15	61.0 - 74.0	65.2	230,000	0
	Lower	1/6	450	450	2,100,000	0
Pesticides/PCBs						
Aroclor-1260	Upper	2/15	23.0 - 29.0	26.0	320	0
	Lower	0/6	ND	ND	1,000	0
4,4'-DDD	Upper	4/15	11.0 - 37.0	20.5	2,700	0
	Lower	2/6	12.0 - 76.0	44.0	8,000	0
4,4'-DDE	Upper	8/15	5.0 - 390	86.6	1,900	0
	Lower	1/6	32.0	32.0	27,000	0
4,4'-DDT	Upper	5/15	6.70 - 53.0	20.7	1,900	0
	Lower	0/6	ND	ND	16,000	0
Aldrin	Upper	1/15	2.00	2.00	38	0
	Lower	0/6	ND	ND	230	0

Table 10.14.2
Grid-Based Locations
Organic Compound Analytical Results for Soil (μg/kg)

Parameter	Sampling Interval	Detection Frequency	Detection Range	Mean	RBC (upper) SSL (lower)	Number of Samples Exceeding RBC or SSL
Chlordane	Upper	2/15	2.20 - 41.0	21.6	1,800	0
	Lower	0/6	ND	ND	5,000	0
Dieldrin	Upper	0/15	ND	ND	40	0
	Lower	1/6	8.30	8.30	2	1
Endosulfan I	Upper	1/15	1.70	1.70	47,000	0
	Lower	0/6	ND	ND	9,000	0
Endosulfan II	Upper	1/15	5.40	5.40	47,000	0
	Lower	0/6	ND	ND	9,000	0
Endosulfan sulfate	Upper	0/15	ND	ND	47,000	0
	Lower	1/6	2.90	2.90	4,600	0
Endrin	Upper	3/15	4.05 - 16.0	9.35	2,300	0
	Lower	0/6	ND	ND	500	0
Endrin aldehyde	Upper	7/15	1.50 - 12.0	3.86	2,300	0
	Lower	0/6	ND	ND	340	0
Heptachlor	Upper	2/15	1.90 - 4.70	3.30	140	0
	Lower	0/6	ND	ND	11,000	0
Heptachlor epoxide	Upper	4/15	8.70 - 12.0	10.3	70	0
	Lower	0/6	ND	ND	330	0
Methyloxychlor	Upper	1/15	3.70	3.70	39,000	0
	Lower	0/6	ND	ND	80,000	0
beta-BHC	Upper	3/15	1.30 - 1.60	1.40	350	0
	Lower	0/6	ND	ND	1.3	0
delta-BHC	Upper	1/15	2.25	2.25	350	0
	Lower	0/6	ND	ND	1.8	0
Dioxins						
TEQs	Upper	1 /1	1.82E-5	1.82E-5	4.3E-3	0
	Lower	NA	NA	NA	1.6	0
OCDD	Upper	1/1	1.19E-2	1.19E-2	4.3	0
	Lower	NA	NA	NA	1080	0
1234678-HpCDD	Upper	1/1	6.3E-4	6.3E-4	0.43	0
	Lower	NA	NA	NA	108	0

Notes:
a = Non-carcinogens were adjusted to equate to a hazard quotient of 0.1
b = Calculated from method described in USEPA *Interim Supplemental Guidance to RAGS: Human Health Risk Assessment*, Bulletin 2, November 1995
NA = Not applicable
ND = Not Detected/None Detected

Table 10.14.3
Grid-Based Locations
Inorganic Analytical Results for Soil (mg/kg)

Parameter	Sample Interval	Detection Frequency	Detection Range	Mean	RBC (upper) SSL (lower)	Number of Samples Exceeding RBC or SSL
Aluminum (Al)	Upper	15/15	3,470 - 27,400	12,825	7,800	9
	Lower	6/6	4,590 - 19,300	9,468	560,000	0
Arsenic (As)	Upper	14/15	0.46 - 19.7	6.36	0.43	13
	Lower	5/6	0.88 - 6.30	3.84	15	0
Barium (Ba)	Upper	15/15	7.8 - 1,180	104	550	1
	Lower	6/6	9.5 - 29.8	18.0	820	0
Beryllium (Br)	Upper	8/15	0.34 - 0.95	0.671	16	0
	Lower	4/6	0.33 - 0.68	0.48	32	0
Cadmium (Cd)	Upper	5/15	0.13 - 0.61	0.39	7.8	0
	Lower	1/6	0.48	0.48	4	0
Chromium (Cr)	Upper	15/15	7.5 - 268	44.0	39	6
	Lower	6/6	7.6 - 41.2	26.9	19	4
Cobalt (Co)	Upper	10/15	0.64 - 5.8	3.98	470	0
	Lower	3/6	2.1 - 3.9	2.73	990	0
Copper (Cu)	Upper	15/15	2.4 - 556	59.1	310	0
	Lower	6/6	1.2 - 12.4	5.75	5,600	0
Lead (Pb)	Upper	15/15	5.0 - 203	51.6	400	0
	Lower	6/6	3.1 - 11.2	6.15	400	0
Manganese (Mn)	Upper	15/15	15.1 - 419	155	160	7
	Lower	6/6	8.6 - 131	59.1	480	0
Mercury (Hg)	Upper	8/15	0.13 - 0.47	0.242	2.3	0
	Lower	0/6	ND	ND	1	0
Nickel (Ni)	Upper	14/15	1.5 - 18.1	9.86	160	0
	Lower	5/6	3.3 - 16.1	9.18	65	0
Selenium (Se)	Upper	11/15	0.5 - 1.1	0.84	39	0
	Lower	5/6	0.59 - 1.4	1.01	2.6	0
Silver (Ag)	Upper	1/15	1.5	1.5	39	0
	Lower	0/6	ND	ND	17	0
Tin (Sn)	Upper	7/15	0.98 - 7.5	3.15	4,700	0
	Lower	0/6	ND	ND	5,500	0
Vanadium (V)	Upper	15/15	8.5 - 53.3	27.1	55	0
	Lower	6/6	10.5 - 35.2	19.1	3,000	0
Zinc (Zn)	Upper	15/15	5.9 - 150	53.4	2,300	0
	Lower	6/6	4.7 - 34.3	18.1	6,200	0

Notes:
NA = Not Applicable/Not Available
ND = Not Detected/Not Determined
NL = Not Listed
mg/kg = milligrams per kilogram
See Table 5.6 for inorganic element screening concentrations and their sources.

Table 10.14.4
Grid-Based Soil Borings
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)
Volatile Organic Compounds (µg/kg)					
Acetone	GDISB006	56	780000	NT	8000
	GDISB013	ND		55	
	GDISB014	22		110	
	GDISB015	43		48	
	GDISB017	62		ND	
	GDISB018	58		42	
Toluene	GDISB002	3	1600000	NT	6000
	GDISB005	4		NT	
	GDISB007	2		NT	
	GDISB012	ND		7	
	GDISB013	ND		4	
	GDISB014	3		2	
	GDISB015	3		21	
	GDISB017	3		ND	
	GDISB018	40		4	
Semivolatile Organic Compounds (µg/kg)					
Anthracene	GDISB015	ND	2300000	160	5900000
Benzoic acid	GDISB005	150	31000000	NT	200000

Table 10.14.4
Grid-Based Soil Borings
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)
Benzo(a)pyrene Equivalents (BEQs)	GDISB007	10.9	87	NT	1600
	GDISB008	9.07		NT	
	GDISB012	4.34		ND	
	GDISB015	ND		78.4	
	GDISB017	66.6		ND	
Benzo(a)anthracene	GDISB011	43	870	NT	800
	GDISB012	59		ND	
	GDISB015	ND		130	
Benzo(a)pyrene	GDISB012	50	87	ND	4000
	GDISB015	ND		52	
Benzo(b)fluoranthene	GDISB007	97	870	NT	2500
	GDISB008	81		NT	
	GDISB012	97		ND	
	GDISB015	ND		120	
	GDISB017	83		ND	
Benzo(k)fluoranthene	GDISB007	120	8700	NT	25000
	GDISB008	97		NT	
	GDISB012	99		ND	
	GDISB015	ND		130	
	GDISB017	98		ND	

Table 10.14.4
Grid-Based Soil Borings
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)
Chrysene	GDISB011	40	87000	NT	80000
	GDISB012	49		ND	
	GDISB015	ND		140	
Butylbenzylphthalate	GDISB007	98	1600000	NT	930000
Di-n-butylphthalate	GDISB014	100	780000	130	2300000
	GDISB015	ND		82	
bis(2-Ethylhexyl)phthalate (BEHP)	GDISB005	100	46000	NT	1800000
	GDISB006	65		NT	
	GDISB008	100		NT	
Fluoranthene	GDISB011	81	310000	NT	2100000
	GDISB012	80		ND	
	GDISB015	ND		650	
	GDISB017	79		ND	
1-Methylnaphthalene	GDISB002	99	310000	NT	72000
2-Methylnaphthalene	GDISB002	60	310000	NT	230000
Phenanthrene	GDISB002	58	230000	NT	660000
	GDISB011	47		NT	
	GDISB012	63		ND	
Pyrene	GDISB008	63	230000	NT	2100000
	GDISB011	63		NT	
	GDISB012	61		ND	
	GDISB015	ND		450	
	GDISB017	74		ND	

Table 10.14.4
Grid-Based Soil Borings
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)
Pesticides/PCBs (µg/kg)					
Aldrin	GDISB002	2	38	NT	230
Aroclor-1260	GDISB002	29	320	NT	1000
	GDISB007	23		NT	
beta-BHC (beta-HCH)	GDISB006	1.3	350	NT	1.3
	GDISB010	1.3		NT	
	GDISB014	1.6		ND	
delta-BHC (delta-HCH)	GDISB006	2.25	350	NT	1.8
Chlordane	GDISB007	2.2	1800	NT	5000
	GDISB013	41		ND	
4,4'-DDD	GDISB006	16	2700	NT	8000
	GDISB010	18		NT	
	GDISB012	ND		12	
	GDISB015	ND		76	
	GDISB017	11		ND	
	GDISB018	37		ND	
4,4'-DDE	GDISB005	5.2	1900	NT	27000
	GDISB006	52.5		NT	
	GDISB008	7.2		NT	
	GDISB010	140		NT	
	GDISB012	ND		7.4	

Table 10.14.4
Grid-Based Soil Borings
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)
4,4'-DDE (Continued)	GDISB013	5		ND	
	GDISB015	ND		32	
	GDISB016	19		ND	
	GDISB017	390		ND	
	GDISB018	74		ND	
4,4'-DDT	GDISB006	11	1900	NT	16000
	GDISB009	12		NT	
	GDISB010	53		NT	
	GDISB017	21		ND	
	GDISB018	6.7		ND	
Dieldrin	GDISB015	ND	40	8.3	2
Endosulfan I	GDISB014	0.7	47000	ND	9000
Endosulfan II	GDISB009	5.4	47000	NT	9000
Endosulfan sulfate	GDISB015	ND	47000	2.9	4600
Endrin	GDISB006	4.05	2300	NT	500
	GDISB017	16		ND	
	GDISB018	8		ND	
Endrin aldehyde	GDISB006	1.5	2300	NT	340
	GDISB007	3.9		NT	
	GDISB008	1.9		NT	
	GDISB010	2.4		NT	
	GDISB015	2.6		ND	
	GDISB017	12		ND	
	GDISB018	2.7		ND	

Table 10.14.4
Grid-Based Soil Borings
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)
Heptachlor	GDISB002	4.7	140	NT	11000
	GDISB010	1.9		NT	
Heptachlor epoxide	GDISB006	9.4	70	NT	330
	GDISB010	8.7		NT	
	GDISB013	11		ND	
	GDISB017	12		ND	
Methoxychlor	GDISB014	3.7	39000	ND	80000
Dioxin Compounds (ng/kg)					
2,3,7,8-TCDD equivalents (TEQs)	GDISB006	1.82E-5	4.3	NT	1600
1234678-HpCDD	GDISB006	0.63	430	NT	108000
OCDD	GDISB006	11.91	4300	NT	1080000
Inorganics (mg/kg)					
Aluminum (Al)	GDISB002	4480	7800	NT	560000
	GDISB005	5360		NT	
	GDISB006	**19800**		NT	
	GDISB007	**27400**		NT	
	GDISB008	**25700**		NT	
	GDISB009	**26400**		NT	
	GDISB010	**23100**		NT	
	GDISB011	5630		NT	
	GDISB012	6170		4590	

Table 10.14.4
Grid-Based Soil Borings
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)
Aluminum (Al) (Continued)	GDISB013	**11000**		6540	
	GDISB014	**8680**		7800	
	GDISB015	**10100**		19300	
	GDISB016	3470		ND	
	GDISB017	**9860**		6880	
	GDISB018	5230		11700	
Arsenic (As)	GDISB002	**4**	0.43	NT	15
	GDISB006	**6.85**		NT	
	GDISB007	**9.3**		NT	
	GDISB008	**11**		NT	
	GDISB009	**11**		NT	
	GDISB010	**9.2**		NT	
	GDISB011	**0.46**		NT	
	GDISB012	**1.6**		4.4	
	GDISB013	**2.1**		0.88	
	GDISB014	**1.9**		ND	
	GDISB015	**2.4**		6.3	
	GDISB016	**1**		ND	
	GDISB017	**19.7**		3.5	
	GDISB018	**8.5**		4.1	

Table 10.14.4
Grid-Based Soil Borings
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)
Barium (Ba)	GDISB002	40.3	550	NT	820
	GDISB005	24.9		NT	
	GDISB006	28.9		NT	
	GDISB007	38.5		NT	
	GDISB008	43.4		NT	
	GDISB009	31.5		NT	
	GDISB010	37.9		NT	
	GDISB011	14.4		NT	
	GDISB012	20.7		9.5	
	GDISB013	20.1		13.8	
	GDISB014	**1180**		29.8	
	GDISB015	24		25.1	
	GDISB016	7.8		ND	
	GDISB017	18.3		10.5	
	GDISB018	22.7		19.4	
Beryllium (Be)	GDISB002	0.4	16	NT	32
	GDISB006	0.74		NT	
	GDISB007	0.88		NT	
	GDISB008	0.87		NT	
	GDISB009	0.95		NT	
	GDISB010	0.73		NT	

Table 10.14.4
Grid-Based Soil Borings
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)
Beryllium (Be) (Continued)	GDISB012	ND		0.33	
	GDISB015	ND		0.68	
	GDISB017	0.46		0.4	
	GDISB018	0.34		0.51	
Cadmium (Cd)	GDISB002	0.13	7.8	NT	4
	GDISB006	0.43		NT	
	GDISB007	0.61		NT	
	GDISB008	0.59		NT	
	GDISB018	0.21		0.48	
Chromium (Cr) (total)	GDISB002	25.4	39	NT	19
	GDISB005	7.5		NT	
	GDISB006	**43.8**		NT	
	GDISB007	**47**		NT	
	GDISB008	**49.9**		NT	
	GDISB009	**53.7**		NT	
	GDISB010	**49.4**		NT	
	GDISB011	12.5		NT	
	GDISB012	18.7		**31.1**	
	GDISB013	18.4		7.6	
	GDISB014	268		23.2	
	GDISB015	17.7		**35.9**	
	GDISB016	8.6		ND	
	GDISB017	21.9		14.9	
	GDISB018	18.1		**41.2**	

Table 10.14.4
Grid-Based Soil Borings
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)
Cobalt (Co)	GDISB002	2.6	470	NT	990
	GDISB005	0.64		NT	
	GDISB006	4.45		NT	
	GDISB007	5.7		NT	
	GDISB008	5.5		NT	
	GDISB009	5.8		NT	
	GDISB010	4.4		NT	
	GDISB014	4		ND	
	GDISB015	ND		3.9	
	GDISB017	2.6		2.1	
	GDISB018	4.1		2.2	
Copper (Cu)	GDISB002	49.3	310	NT	5600
	GDISB005	4.3		NT	
	GDISB006	41.45		NT	
	GDISB007	24.6		NT	
	GDISB008	34.6		NT	
	GDISB009	19.1		NT	
	GDISB010	95.9		NT	
	GDISB011	4.2		NT	
	GDISB012	6		8.6	
	GDISB013	18.9		1.2	

Table 10.14.4
Grid-Based Soil Borings
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)
Copper (Cu) (Continued)	GDISB014	6.2		1.7	
	GDISB015	13.9		8.5	
	GDISB016	2.4		ND	
	GDISB017	9		2.1	
	GDISB018	**556**		12.4	
Lead (Pb)	GDISB002	27.3	400	NT	400
	GDISB005	8.6		NT	
	GDISB006	45		NT	
	GDISB007	24.8		NT	
	GDISB008	46.5		NT	
	GDISB009	20.2		NT	
	GDISB010	203		NT	
	GDISB011	21.1		NT	
	GDISB012	140		3.1	
	GDISB013	33.3		4.6	
	GDISB014	5.8		6.4	
	GDISB015	24.3		11.2	
	GDISB016	5		ND	
	GDISB017	95.5		4.4	
	GDISB018	73.4		7.2	

Table 10.14.4
Grid-Based Soil Borings
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)
Manganese (Mn)	GDISB002	77.1	160	NT	480
	GDISB005	15.1		NT	
	GDISB006	**351**		NT	
	GDISB007	**419**		NT	
	GDISB008	**275**		NT	
	GDISB009	**266**		NT	
	GDISB010	**291**		NT	
	GDISB011	21.5		NT	
	GDISB012	37.2		44.4	
	GDISB013	28.6		8.6	
	GDISB014	**254**		62.7	
	GDISB015	30.4		131	
	GDISB016	33.3		ND	
	GDISB017	**187**		53.7	
	GDISB018	40.5		54.5	
Mercury (Hg)	GDISB006	0.16	2.3	NT	1
	GDISB007	0.21		NT	
	GDISB008	0.3		NT	
	GDISB009	0.23		NT	
	GDISB010	0.29		NT	
	GDISB013	0.13		ND	
	GDISB015	0.15		ND	
	GDISB018	0.47		ND	

Table 10.14.4
Grid-Based Soil Borings
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)
Nickel (Ni)	GDISB002	11.4	160	NT	65
	GDISB005	1.5		NT	
	GDISB006	14.45		NT	
	GDISB007	15.3		NT	
	GDISB008	16.3		NT	
	GDISB009	15.9		NT	
	GDISB010	18.1		NT	
	GDISB011	4.2		NT	
	GDISB012	5.6		11.7	
	GDISB013	5.4		ND	
	GDISB014	7.3		3.3	
	GDISB015	6.1		11.3	
	GDISB017	5.5		3.5	
	GDISB018	11		16.1	
Selenium (Se)	GDISB002	0.9	39	NT	2.6
	GDISB005	0.96		NT	
	GDISB006	0.91		NT	
	GDISB008	1.1		NT	
	GDISB009	0.7		NT	
	GDISB010	1		NT	
	GDISB012	0.5		1.4	

Table 10.14.4
Grid-Based Soil Borings
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)
Selenium (Se) (Continued)	GDISB013	ND		0.59	
	GDISB014	0.82		ND	
	GDISB015	0.68		0.88	
	GDISB017	0.58		0.99	
	GDISB018	1.1		1.2	
Silver (Ag)	GDISB018	1.5	39	ND	17
Tin (Sn)	GDISB002	2.5	4700	NT	5500
	GDISB006	1.1		NT	
	GDISB008	2.2		NT	
	GDISB010	6.8		NT	
	GDISB013	0.98		ND	
	GDISB017	1		ND	
	GDISB018	7.5		ND	
Vanadium (V)	GDISB002	15	55	NT	3000
	GDISB005	8.6		NT	
	GDISB006	38.55		NT	
	GDISB007	49.3		NT	
	GDISB008	51.6		NT	
	GDISB009	53.3		NT	
	GDISB010	43.9		NT	
	GDISB011	15.3		NT	

Table 10.14.4
Grid-Based Soil Borings
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)
Vanadium (V) (Continued)	GDISB012	20.6		17.9	
	GDISB013	19.4		10.5	
	GDISB014	17.5		12.4	
	GDISB015	26.6		35.2	
	GDISB016	8.5		ND	
	GDISB017	25.5		14.6	
	GDISB018	12.9		23.7	
Zinc (Zn)	GDISB002	46	2300	NT	6200
	GDISB005	5.9		NT	
	GDISB006	84.25		NT	
	GDISB007	84.8		NT	
	GDISB008	92.2		NT	
	GDISB009	62.9		NT	
	GDISB010	150		NT	
	GDISB011	16.7		NT	
	GDISB012	22.1		21.4	
	GDISB013	28		4.7	
	GDISB014	9.6		6.4	
	GDISB015	36.5		34.3	

Table 10.14.4
Grid-Based Soil Borings
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Subsurface Conc.	Soil to Groundwater SSL* (DAF=10)
Zinc (Zn) (Continued)	GDISB016	11.4		ND	
	GDISB017	37.4		12.4	
	GDISB018	113		29.4	

Notes:
a = Background value for non clay samples
* = Residential RBCs (THQ=0.1) were used as a reference concentration for upper interval samples. Generic soil-to groundwater SSLs (DAF=10) from *Soil Screening Guidance: Technical Background Document* (USEPA, 1996b) were used as a reference concentration for lower interval samples.
Bold concentrations exceed the RBCs, or SSL
All background values for Zone I are based on twice the means of the grid sample concentrations. Background values for the groundwater are based on two sampling rounds in two wells at each depth.
NA = Not applicable/not available
ND = Not detected
NI = Not installed
NL = Not listed
NT = Not taken
ng/kg = Nanograms per kilogram
μg/kg = Micrograms per kilogram
pg/L = Picograms per liter
μg/L = Micrograms per liter
mg/kg = Milligrams per kilogram
mg/L = Milligrams per liter

Volatile Organic Compounds in Soil

Acetone and toluene were detected in grid based soil samples. Neither exceeded the RBC or SSL.

Semivolatile Organic Compounds in Soil

Fifteen semivolatile organic compounds were detected in grid-based soil samples. None exceeded the RBC or SSL

Pesticides and PCBs in Soil

Sixteen pesticides were detected in the grid-based soil samples. None exceeded the RBC or SSL.

Aroclor-1260 was detected in only two grid-based soil samples, both below the RBC and SSL.

Other Organic Compounds in Soil

Dioxins were only analyzed in one grid-based soil sample (GDISB006). In accordance with recent guidance, TEQs were calculated for this sample. The calculated TEQ was well below the RBC.

Inorganics in Soil

Seventeen metals were detected in grid-based soil samples. As noted previously, this data was used to calculate surface and subsurface soil background values for the Zone I soils.

10.14.3 Groundwater Sampling and Analysis

The *Final Zone I RFI Work Plan* (E/A&H, February 1995) proposed 18 shallow and 18 deep grid-based monitoring wells. Nineteen shallow and 19 deep grid-based wells were installed. The additional deep grid-based pair was installed at the end of the peninsula to characterize any potential discharges to the Cooper River and Shipyard Creek. Well locations are shown on Figure 3.2 (Section 3). As proposed in the *Final Zone I RFI Work Plan* (E/A&H, February 1995), groundwater samples were collected for TDS, chloride, sulfate and the standard suite of metals, cyanide, pesticides, and PCBs at DQO Level III. Organotin samples were also collected. Dioxins samples were collected from five shallow wells and five deep wells. Six samples were duplicated and submitted for Appendix IX parameters at DQO Level IV. Table 10.14.5 summarizes the grid-based groundwater sampling.

10.14.4 Nature and Extent of Chemicals Detected in Groundwater

Table 10.14.6 summarizes the organic analytical results for shallow groundwater. Table 10.14.7 summarizes inorganic analytical results for shallow groundwater. Table 10.14.8 summarizes all analytes detected in the shallow groundwater from the Zone I grid-based wells. Table 10.14.9 summarizes the organic analytical results for deep groundwater. Tables 10.14.10 summarizes inorganic analytical results for deep groundwater. Table 10.14.11 summarizes all analytes detected in the deep groundwater from the Zone I grid-based wells.

The following grid-based well pairs were discussed in greater detail within the site specific nature and extent of chemicals in groundwater subsections

AOC/SWMU	Grid-based Well Pair(s)
671	GDI017/17D
672/673	GDI018/18d
675/676/677	GDI015/15D
678/679*	GDI014/14D
681*	GDI013/13D
685	GDI010/10D
687/16	GDI008/08D
688	GDI007/07D
689/690	GDI001/01D, GDI002/02D, GDI003/03D, GDI004/04D, GDI019/19D, GDH010/10D, GDH011/11D
12	GDI003/03d
177/RTC	GDI016/16D
DMA	GDI001/01D through GDI008/08D

* Note that specific discussion on AOC 678/679 and AOC 681 are not included in this RFI submittal but will be presented as an addendum to this report.

Table 10.14.5
Grid-Based Locations
Groundwater Sampling Summary

Sampling Round	Sampling Date	Wells Sampled	Sample Analyses	Comments
1	05/23/95 05/24/95 06/01/95 06/02/95 06/06/95 06/07/95 06/08/95 06/09/95	GDI001/01D through GDI019/19D	Standard Suite, Organotins, TDS, Sulfates, Chloride, Dioxins	Eighteen grid-well pairs were planned. An additional grid pair was installed to characterize any potential discharge to the Cooper River and Shipyard Creek.
2	12/05/95 12/06/95 12/08/95 12/11/95 12/12/95 12/13/95 12/15/95	GDI001/01D through GDI019/19D	Standard Suite, TDS, Sulfate, Chloride	
3	05/15/96 05/16/96 05/20/96 05/21/96 05/22/96 05/23/96 05/24/96 05/28/96 05/29/96 05/30/96 05/31/96	GDI001/01D through GDI019/19D	Standard Suite, TDS, Sulfate, Chloride	
4	08/19/96 08/20/96 08/21/96 08/22/96 08/23/96 08/26/96 08/27/96 08/28/96 08/29/96 08/30/96 09/04/96 09/10/96	GDI001/01D through GDI019/19D	Standard Suite, TDS, Sulfate, Chloride	
5	04/14/98 04/15/98	GDI007/07D GDI008/08D GDI013/13D	SVOCs Metals	
6	08/19/98 08/20/98	GDI007/07D GDI008/08D GDI013/13D	VOCs SVOCs Metals	

Note:
a = Standard suite includes VOCs, SVOCs, metals, cyanide, pesticides, and PCBs.

Table 10.14.6
Grid-Based Locations
Organic Compound Analytical Results for Shallow Groundwater (μg/L)

Parameter	Sample Round	Detection Frequency	Detection Range	Mean	Tap-Water RBC/MCL	Number of Samples Exceeding Lower of RBC or MCL
Volatile Organic Compounds						
1,1-Dichloroethane	First	1/19	2.0	2.0	80/NA	0
	Second	1/19	1.0	1.0		0
	Third	0/19	ND	ND		NA
	Fourth	0/19	ND	ND		NA
	Fifth	0/0	ND	ND		NA
	Sixth	0/3	NA	NA		NA
4-Methyl-2-Pentanone (MIBK)	First	0/19	ND	ND	290/NA	NA
	Second	0/19	ND	ND		NA
	Third	0/19	ND	ND		NA
	Fourth	1/19	4.0	4.0		0
	Fifth	0/0	NA	NA		NA
	Sixth	0/3	ND	ND		NA
2-Butanone	First	0/19	ND	ND	190/NA	NA
	Second	2/19	3.0 - 3.0	3.0		0
	Third	0/19	ND	ND		NA
	Fourth	0/19	ND	ND		NA
	Fifth	0/0	NA	NA		NA
	Sixth	0/3	ND	ND		NA
1,2-Dichloroethane	First	0/19	ND	ND	0.12/5	NA
	Second	0/19	ND	ND		NA
	Third	0/19	ND	ND		NA
	Fourth	1/19	2.0	2.0		0
	Fifth	0/0	NA	NA		NA
	Sixth	0/3	ND	ND		NA
1,2-Dichloroethene (total)	First	1/19	2.0	2.0	5.5/NA	0
	Second	1/19	7.0	7.0		0
	Third	1/19	5.0	5.0		0
	Fourth	1/19	4.0	4.0		0
	Fifth	0/0	NA	NA		NA
	Sixth	1/3	2.0	2.0		0
1,1,2,2-Tetrachloroethane	First	0/19	ND	ND	0.053/NA	NA
	Second	0/19	ND	ND		NA
	Third	0/19	ND	ND		NA
	Fourth	1/19	1.0	1.0		0
	Fifth	0/0	NA	NA		NA
	Sixth	0/3	ND	ND		NA
Acetone	First	6/19	7.0 - 60.0	19.0	370/NA	0
	Second	2/19	10.0 - 64.0	37.0		0
	Third	2/19	5.0 - 4800	2402		1
	Fourth	0/19	ND	ND		NA
	Fifth	0/0	NA	NA		NA
	Sixth	0/3	ND	ND		NA

Table 10.14.6
Grid-Based Locations
Organic Compound Analytical Results for Shallow Groundwater (µg/L)

Parameter	Sample Round	Detection Frequency	Detection Range	Mean	Tap-Water RBC/MCL	Number of Samples Exceeding Lower of RBC or MCL
Carbon Disulfide	First	1/19	9.0	9.0	100/NA	0
	Second	0/19	ND	ND		NA
	Third	4/19	1.0 - 13.0	4.38		0
	Fourth	1/19	3.0	3.0		0
	Fifth	0/0	NA	NA		NA
	Sixth	0/3	ND	NA		NA
Chlorobenzene	First	1/19	2.0	2.0	3.5/NA	0
	Second	0/19	ND	ND		NA
	Third	0/19	ND	ND		NA
	Fourth	0/19	ND	ND		NA
	Fifth	0/0	NA	NA		NA
	Sixth	0/3	ND	ND		NA
Ethylbenzene	First	1/19	3.0	3.0	130/700	0
	Second	1/19	2.0	2.0		0
	Third	0/19	ND	ND		NA
	Fourth	0/19	ND	ND		NA
	Fifth	0/0	NA	NA		NA
	Sixth	0/3	ND	ND		NA
Methylene chloride	First	0/19	ND	ND	4.1/NA	NA
	Second	2/19	27.0 - 28.0	27.5		0
	Third	0/19	ND	ND		NA
	Fourth	0/19	ND	ND		NA
	Fifth	0/0	NA	NA		NA
	Sixth	0/3	ND	ND		NA
Tetrachloroethene	First	1/19	4.0	4.0	1.1/5.0	1
	Second	1/19	1.0	1.0		0
	Third	0/19	ND	ND		NA
	Fourth	1/19	4.0	4.0		1
	Fifth	0/0	NA	NA		NA
	Sixth	0/3	ND	ND		ND
Toluene	First	0/19	ND	ND	75/1000	NA
	Second	4/19	2.0 - 9.0	3.75		0
	Third	0/19	ND	ND		NA
	Fourth	0/19	ND	ND		NA
	Fifth	0/0	NA	NA		NA
	Sixth	0/3	ND	ND		NA
Trichloroethene	First	1/19	6.0	6.0	1.6/5.0	1
	Second	1/19	4.0	4.0		1
	Third	1/19	10.0	10.0		1
	Fourth	1/19	12.0	12.0		1
	Fifth	0/0	NA	NA		NA
	Sixth	0/3	ND	ND		NA

Table 10.14.6
Grid-Based Locations
Organic Compound Analytical Results for Shallow Groundwater (μg/L)

Parameter	Sample Round	Detection Frequency	Detection Range	Mean	Tap-Water RBC/MCL	Number of Samples Exceeding Lower of RBC or MCL
Xylene (Total)	First	1/19	6.0	6.0	1,200/10,000	0
	Second	2/19	2.0 - 10.0	6.0		0
	Third	1/19	2.0	2.0		0
	Fourth	0/19	ND	ND		NA
	Fifth	0/0	NA	NA		NA
	Sixth	0/3	ND	ND		NA
Semivolatile Organic Compounds						
1-Methyl naphthalene	First	2/19	6.0 - 10.0	8.0	150/NA	0
	Second	0/19	ND	ND		NA
	Third	0/19	ND	ND		NA
	Fourth	0/19	ND	ND		NA
	Fifth	0/3	ND	ND		NA
	Sixth	0/3	ND	ND		NA
2,4-Dimethylphenol	First	0/19	ND	ND	73/NA	NA
	Second	2/19	1.0 - 6.0	3.5		0
	Third	0/19	ND	ND		NA
	Fourth	1/19	2.0	2.0		0
	Fifth	0/3	ND	ND		NA
	Sixth	0/3	ND	ND		NA
2-Methyl naphthalene	First	2/19	1.0 - 9.0	5.0	150/NA	0
	Second	2/19	5.0 - 7.0	6.0		0
	Third	1/19	2.0	2.0		0
	Fourth	1/19	2.0	2.0		0
	Fifth	0/3	ND	ND		NA
	Sixth	0/3	ND	ND		NA
3-Methylphenol (m-cresol)	First	1/19	19.0	19.0	180/NA	0
	Second	0/19	ND	ND		NA
	Third	0/19	ND	ND		NA
	Fourth	0/19	ND	ND		NA
	Fifth	0/3	ND	ND		NA
	Sixth	0/3	ND	ND		NA
4-Methylphenol (p-cresol)	First	1/19	19.0	19.0	18/NA	0
	Second	1/19	3.0	3.0		0
	Third	0/19	ND	ND		NA
	Fourth	0/19	ND	ND		NA
	Fifth	0/3	ND	ND		NA
	Sixth	0/3	ND	ND		NA
1,2,3,4-Tetrachlorobenzene	First	1/19	1.0	1.0	0.18/NA	0
	Second	0/19	ND	ND		NA
	Third	0/19	ND	ND		NA
	Fourth	0/19	ND	ND		NA
	Fifth	0/3	ND	ND		NA
	Sixth	0/3	ND	ND		NA

Table 10.14.6
Grid-Based Locations
Organic Compound Analytical Results for Shallow Groundwater (μg/L)

Parameter	Sample Round	Detection Frequency	Detection Range	Mean	Tap-Water RBC/MCL	Number of Samples Exceeding Lower of RBC or MCL
1,2,4-Trichlorobenzene	First	1/19	4.0	4.0	19/70	0
	Second	0/19	ND	ND		NA
	Third	0/19	ND	ND		NA
	Fourth	0/19	ND	ND		NA
	Fifth	0/3	ND	ND		NA
	Sixth	0/3	ND	ND		NA
2,4,6-Trichlorophenol	First	0/19	ND	ND	6.1/NA	NA
	Second	1/19	2.0	2.0		0
	Third	0/19	ND	ND		NA
	Fourth	0/19	ND	ND		NA
	Fifth	0/3	ND	ND		NA
	Sixth	0/3	ND	ND		NA
Acenaphthene	First	3/19	2.0 - 10.0	6.33	220/NA	0
	Second	4/19	2.0 - 17.0	8.37		0
	Third	5/19	3.0 - 10.0	5.5		0
	Fourth	6/19	3.5 - 13.0	5.75		0
	Fifth	0/3	ND	ND		NA
	Sixth	0/3	ND	ND		NA
Acetophenone	First	3/19	1.0 - 1.0	1.0	0.0042/NA	0
	Second	0/19	ND	ND		NA
	Third	0/19	ND	ND		NA
	Fourth	0/19	ND	ND		NA
	Fifth	0/3	ND	ND		NA
	Sixth	0/3	ND	ND		NA
Benzoic acid	First	1/19	2.0	2.0	15,000/NA	0
	Second	3/19	1.0 - 2.0	1.67		0
	Third	6/19	1.0 - 3.0	1.83		0
	Fourth	5/19	1.0 - 2.0	1.20		0
	Fifth	0/3	ND	ND		NA
	Sixth	0/3	ND	ND		NA
Diethylphthalate	First	1/19	2.0	2.0	2,900/NA	0
	Second	0/19	ND	ND		NA
	Third	0/19	ND	ND		NA
	Fourth	0/19	ND	ND		NA
	Fifth	0/3	ND	ND		NA
	Sixth	0/3	ND	ND		NA
Di-n-butylphthalate	First	1/19	3.0	3.0	370/NA	0
	Second	1/19	1.0	1.0		0
	Third	0/19	ND	ND		NA
	Fourth	0/19	ND	ND		NA
	Fifth	0/3	ND	ND		NA
	Sixth	0/3	ND	ND		NA

Table 10.14.6
Grid-Based Locations
Organic Compound Analytical Results for Shallow Groundwater (μg/L)

Parameter	Sample Round	Detection Frequency	Detection Range	Mean	Tap-Water RBC/MCL	Number of Samples Exceeding Lower of RBC or MCL
Dibenzofuran	First	2/19	1.0 - 6.0	3.5	2.4/NA	1
	Second	2/19	4.0 - 5.0	4.5		1
	Third	2/19	1.0 - 3.0	2.0		1
	Fourth	1/19	2.0	2.0		0
	Fifth	0/3	ND	ND		NA
	Sixth	0/3	ND	ND		NA
Fluorene	First	2/19	2.0 - 6.0	4.0	150/NA	0
	Second	3/19	1.0 - 6.0	4.33		0
	Third	3/19	1.0 - 4.0	2.67		0
	Fourth	3/19	2.0 - 4.0	3.0		0
	Fifth	0/3	ND	ND		NA
	Sixth	0/3	ND	ND		NA
Naphthalene	First	2/19	23.0 - 28.0	25.5	150/NA	0
	Second	4/19	2.0 - 93.0	31.5		0
	Third	3/19	3.0 - 31.0	13.3		0
	Fourth	3/19	6.0 - 15.0	1.7		0
	Fifth	0/3	ND	ND		NA
	Sixth	0/3	ND	ND		NA
Pentachlorophenol	First	0/19	ND	ND	0.56/1.0	NA
	Second	1/19	1.0	1.0		1
	Third	0/19	ND	ND		NA
	Fourth	0/19	ND	ND		NA
	Fifth	0/3	ND	ND		NA
	Sixth	0/3	ND	ND		NA
Phenanthrene	First	1/19	9.0	9.0	110/NA	0
	Second	2/19	1.0 - 4.0	2.5		0
	Third	1/19	3.0	3.0		0
	Fourth	1/19	2.0	2.0		0
	Fifth	0/3	ND	ND		NA
	Sixth	0/3	ND	ND		NA
bis-(2-Ethylhexyl)phthalate	First	1/19	15.0	15.0	4.8/NA	1
	Second	0/19	ND	ND		NA
	Third	2/19	2.0 - 11.0	6.5		1
	Fourth	0/19	ND	ND		NA
	Fifth	0/3	ND	ND		NA
	Sixth	0/3	ND	ND		NA
Pesticides and PCBs						
Aroclor-1260	First	1/19	1.3	1.3	0.033/0.5	1
	Second	0/19	ND	ND		NA
	Third	0/19	ND	ND		NA
	Fourth	0/19	ND	ND		NA

Table 10.14.6
Grid-Based Locations
Organic Compound Analytical Results for Shallow Groundwater (μg/L)

Parameter	Sample Round	Detection Frequency	Detection Range	Mean	Tap-Water RBC/MCL	Number of Samples Exceeding Lower of RBC or MCL
4,4'-DDE	First	1/19	1.50	1.5	0.2/NA	1
	Second	0/19	ND	ND		NA
	Third	0/19	ND	ND		NA
	Fourth	0/19	ND	ND		NA
4,4'-DDT	First	1/19	14.0	14.0	0.2/NA	1
	Second	0/19	ND	ND		NA
	Third	0/19	ND	ND		NA
	Fourth	0/19	ND	ND		NA
Dieldrin	First	1/19	5.1	5.1	0.0042/NA	1
	Second	0/19	ND	ND		NA
	Third	0/19	ND	ND		NA
	Fourth	0/19	ND	ND		NA
Endosulfan II	First	1/19	1.6	1.6	22/NA	0
	Second	0/19	ND	ND		NA
	Third	0/19	ND	ND		NA
	Fourth	0/19	ND	ND		NA
Endosulfan sulfate	First	1/19	2.1	2.1	22/NA	0
	Second	0/19	ND	ND		NA
	Third	0/19	ND	ND		NA
	Fourth	0/19	ND	ND		NA
Endrin Aldehyde	First	1/19	1.7	1.7	1.1/2.0	1
	Second	0/19	ND	ND		NA
	Third	0/19	ND	ND		NA
	Fourth	0/19	ND	ND		NA
Heptachlor	First	1/19	0.0015	0.0015	0.0023/0.4	0
	Second	0/19	ND	ND		NA
	Third	0/19	ND	ND		NA
	Fourth	0/19	ND	ND		NA
Methyl parathion	First	1/19	0.24	0.24	0.91/NA	0
	Second	0/19	ND	ND		NA
	Third	0/19	ND	ND		NA
	Fourth	0/19	ND	ND		NA
Parathion	First	1/19	0.17	0.17	22/NA	0
	Second	0/19	ND	ND		NA
	Third	0/19	ND	ND		NA
	Fourth	0/19	ND	ND		NA
Beta-BHC	First	4/19	0.022 - 7.1	1.82	0.037/NA	2
	Second	0/19	ND	ND		NA
	Third	0/19	ND	ND		NA
	Fourth	0/19	ND	ND		NA

Table 10.14.6
Grid-Based Locations
Organic Compound Analytical Results for Shallow Groundwater (μg/L)

Parameter	Sample Round	Detection Frequency	Detection Range	Mean	Tap-Water RBC/MCL	Number of Samples Exceeding Lower of RBC or MCL
gamma-BHC (Lindane)	First	1/19	0.62	0.62	0.052/0.2	1
	Second	0/19	ND	ND		NA
	Third	0/19	ND	ND		NA
	Fourth	0/19	ND	ND		NA
Dioxins						
TEQs	First	8/19	7.57E08 - 9.70E-7	4.65E-7	4.5E-4/3.0E-2	0
	Second	4/19	8.9E-9 - 8.92E-8	6.6E-7		0
	Third	3/19	3.56E-8 - 1.76E-6	1.11E-6		0
	Fourth	4/19	3.29E-9 - 4.32E-6	1.11E-6		0
1234678-HpCDD	First	4/19	2.67E-6 - 4.49E-6	3.75E-6	4.5E-2/NA	0
	Second	0/19	ND	ND		NA
	Third	0/19	ND	ND		NA
	Fourth	1/19	1.0E-5	1.0E-5		0
1234678-HpCDF	First	7/19	1.93E-6 - 3.69E-5	1.03E-5	4.5E-2/NA	0
	Second	3/19	3.81E-6 - 7.46E-6	5.89E-6		0
	Third	3/19	3.56E-6 - 4.19E-5	2.90E-5		0
	Fourth	2/19	8.08E-6 - 8.02E-5	4.41E-5		0
123478-HxCDF	First	0/19	ND	ND	4.5E-3/NA	NA
	Second	0/19	ND	ND		NA
	Third	2/19	1.08E-5 - 1.31E-5	1.19E-5		0
	Fourth	0/19	ND	ND		NA
123678-HxCDD	First	0/19	ND	ND	4.5E-3/NA	NA
	Second	0/19	ND	ND		NA
	Third	0/19	ND	ND		NA
	Fourth	1/19	6.34E-6	6.34E-6		0
123678-HxCDF	First	0/19	ND	ND	4.5E-3/NA	NA
	Second	0/19	ND	ND		NA
	Third	0/19	ND	ND		NA
	Fourth	1/19	8.4E-6	8.4E-6		0
123789-HxCDF	First	3/19	2.93E-6 - 4.92E-6	3.88E-6	4.5E-3/NA	0
	Second	0/19	ND	ND		NA
	Third	0/19	ND	ND		NA
	Fourth	0/19	ND	ND		NA
234678-HxCDF	First	0/19	ND	ND	4.5E-3/NA	NA
	Second	0/19	ND	ND		NA
	Third	0/19	ND	ND		NA
	Fourth	1/19	8.54E-6	8.54E-6		0
OCDD	First	8/19	8.75E-6 - 4.32E-5	2.06E-5	4.5E-1	0
	Second	4/19	6.54E-6 - 4.22E-5	1.65E-5		0
	Third	1/19	1.94E-5	1.94E-5		0
	Fourth	3/19	3.29E-6 - 3.28E-5	2.22E-5		0

Table 10.14.6
Grid-Based Locations
Organic Compound Analytical Results for Shallow Groundwater (μg/L)

Parameter	Sample Round	Detection Frequency	Detection Range	Mean	Tap-Water RBC/MCL	Number of Samples Exceeding Lower of RBC or MCL
OCDF	First	7/19	1.55E-6 - 1.06E-4	2.45E-5	4.5E-1/NA	0
	Second	3/19	6.08E-6 - 8.23E-6	7.04E-6		0
	Third	2/19	2.92E-5 - 3.4E-5	3.16E-5		0
	Fourth	2/19	7.68E-6 - 1.53E-4	8.03E-5		0

Notes:
NA = Not Applicable/Not Available
ND = Not Detected/Not Determined
NL = Not Listed
μg/L = micrograms per liter
See Table 5.5 for inorganic screening concentrations and their sources.

Table 10.14.7
Grid-based Locations
Inorganic Analytical Results for Shallow Groundwater (μg/L)

Parameters	Sample Round	Detection Frequency	Detection Range	Mean	Tap-water RBC/MCL	Number of Samples Exceeding Lower of RBC or MCL
Aluminum (Al)	First	3/19	341 - 1190	661	3,700/NL	0
	Second	9/19	38.9 - 1550	274		0
	Third	6/19	25.1 - 814	182		0
	Fourth	5/19	32.1 - 1440	352		0
	Fifth	1/3	543	543		0
	Sixth	1/3	141	141		0
Antimony (Sb)	First	0/19	ND	ND	1.5/6.0	0
	Second	1/19	5.5	5.5		1
	Third	5/19	3.1 - 6.1	4.2		5
	Fourth	1/19	8.4	8.4		1
	Fifth	0/3	ND	ND		0
	Sixth	0/3	ND	ND		0
Arsenic (As)	First	6/19	6.4 - 22.9	14.3	0.045/50	5
	Second	8/19	9.8 - 66.3	21.7		8
	Third	11/19	2.9 - 33.5	13.7		11
	Fourth	9/19	3.8 - 46.2	15.6		9
	Fifth	1/3	9.0	9.0		1
	Sixth	2/3	6.5 - 23.9	15.2		2
Barium (Ba)	First	19/19	7.1 - 278	61.2	260/2,000	1
	Second	19/19	2.5 - 147	47.6		0
	Third	8/19	12.6 - 163	45.6		0
	Fourth	19/19	4.8 - 153	52.9		0
	Fifth	2/3	24.9 - 54.2	39.5		0
	Sixth	2/3	23.9 - 56.2	40.1		0
Beryllium (Be)	First	0/19	ND	ND	7.3/4	0
	Second	2/19	1.0 - 1.1	1.05		0
	Third	6/19	0.73 - 1.2	0.968		0
	Fourth	2/19	0.32 - 0.46	0.39		0
	Fifth	0/3	ND	ND		0
	Sixth	0/3	ND	ND		0
Cadmium (Cd)	First	2/19	0.43 - 0.76	0.595	1.8/5	0
	Second	1/19	2.3	2.3		0
	Third	0/19	ND	ND		0
	Fourth	0/19	ND	ND		0
	Fifth	1/3	0.45	0.45		0
	Sixth	0/3	ND	ND		0
Chromium (Cr)	First	13/19	1.1 - 8.1	3.71	18/100	0
	Second	5/19	1.0 - 3.4	1.91		1
	Third	7/19	0.94 - 23.8	5.21		0
	Fourth	8/19	0.9 - 14.3	4.31		0
	Fifth	0/3	ND			0
	Sixth	3/3	12.1 - 22.7	16.1		0
Cobalt (Co)	First	6/19	0.66 - 2.1	1.10	220/NL	0
	Second	1/19	4.2	4.2		0
	Third	0/19	ND	ND		0
	Fourth	1/19	2.2	2.2		0
	Fifth	2/3	1.0 - 1.3	1.15		0
	Sixth	0/3	ND	ND		0

Table 10.14.7
Grid-based Locations
Inorganic Analytical Results for Shallow Groundwater (μg/L)

Parameters	Sample Round	Detection Frequency	Detection Range	Mean	Tap-water RBC/MCL	Number of Samples Exceeding Lower of RBC or MCL
Copper (Cu)	First	6/19	1.2 - 3.2	1.85	150/1,300	0
	Second	1/19	4.4	4.4		0
	Third	2/19	1.6 - 5.2	3.4		0
	Fourth	0/19	ND	ND		0
	Fifth	0/3	ND	ND		0
	Sixth	0/3	ND	ND		0
Cyanide (CN)	First	4/19	15.6 - 35.2	24.5	73/200	0
	Second	0/19	ND	ND		0
	Third	2/19	4.7 - 5.4	5.05		0
	Fourth	2/19	3.0 - 16.7	9.85		0
	Fifth	0/3	ND	ND		0
	Sixth	0/3	ND	ND		0
Lead (Pb)	First	16/19	1.9 - 15.6	4.78	15/15	1
	Second	2/19	4.0 - 15.7	9.85		1
	Third	1/19	4.7	4.7		0
	Fourth	3/19	2.1 - 13.0	6.43		0
	Fifth	0/3	ND	ND		0
	Sixth	0/3	ND	ND		0
Manganese (Mn)	First	19/19	23.4 - 4525	818	73/NL	17
	Second	19/19	36.6 - 3560	906		17
	Third	18/19	41.7 - 3230	814		16
	Fourth	19/19	46.2 - 3560	602		17
	Fifth	2/3	1240 - 2550	1895		2
	Sixth	3/3	126 - 1480	775		3
Mercury (Hg)	First	0/19	ND	ND	1.1/2	0
	Second	1/19	1.1	1.1		1
	Third	0/19	ND	ND		0
	Fourth	1/19	0.12	0.12		0
	Fifth	0/3	ND	ND		0
	Sixth	0/3	ND	ND		0
Nickel (Ni)	First	11/19	1.5 - 4.9	3.3	73/100	0
	Second	13/19	1.0 - 16.3	3.57		0
	Third	7/19	1.3 - 12.8	5.44		0
	Fourth	10/19	1.0 - 11.6	4.56		0
	Fifth	1/3	9.7	9.7		0
	Sixth	0/3	ND	ND		0
Selenium (Se)	First	0/19	ND	ND	18/50	0
	Second	0/19	ND	ND		0
	Third	0/19	ND	ND		0
	Fourth	0/19	ND	ND		0
	Fifth	0/3	ND	ND		0
	Sixth	1/3	26.7	26.7		1
Silver (Ag)	First	0/19	ND	ND	18/NL	0
	Second	0/19	ND	ND		0
	Third	0/19	ND	ND		0
	Fourth	2/19	1.3 - 4.6	2.95		0
	Fifth	0/3	ND	ND		0
	Sixth	0/3	ND	ND		0

Table 10.14.7
Grid-based Locations
Inorganic Analytical Results for Shallow Groundwater (µg/L)

Parameters	Sample Round	Detection Frequency	Detection Range	Mean	Tap-water RBC/MCL	Number of Samples Exceeding Lower of RBC or MCL
Thallium (Tl)	First	0/19	ND	ND	0.26/2	0
	Second	5/19	5.4 - 7.5	6.26		5
	Third	4/19	2.8 - 5.5	3.7		4
	Fourth	2/4	3.5 - 4.1	3.8		2
	Fifth	0/3	ND	ND		0
	Sixth	0/3	ND	ND		0
Tin (Sn)	First	0/19	ND	ND	2,200/NL	0
	Second	0/19	ND	ND		0
	Third	0/19	ND	ND		0
	Fourth	4/19	2.7 - 3.3	3.05		0
	Fifth	0/3	ND	ND		0
	Sixth	0/3	ND	ND		0
Vanadium (V)	First	14/19	0.44 - 10.9	3.10	26/NL	0
	Second	16/19	1.2 - 18.8	4.22		0
	Third	6/19	1.3 - 8.3	4.58		0
	Fourth	6/19	2.35 - 13.9	7.68		0
	Fifth	0/3	ND	ND		0
	Sixth	0/3	ND	ND		0
Zinc (Zn)	First	19/19	7.1 - 53.4	16.1	1,100/NL	0
	Second	4/19	4.1 - 11.1	6.55		0
	Third	0/19	ND			0
	Fourth	5/19	10.0 - 24.4	16.7		0
	Fifth	1/3	24.5	24.5		0
	Sixth	1/3	316	316		0

Notes:
NA = Not Applicable/Not Available
ND = Not Detected/Not Determined
NL = Not Listed
µg/L = micrograms per liter
See Table 5.6 for inorganic screening concentrations and their sources.

Table 10.14.8
Grid-Based Wells
Analytes Detected in Shallow Groundwater

Parameters	Location	1st Round	2nd Round	3rd Round	4th Round	5th Round	6th Round	Tap Water RBC*	MCL/SMCL*
Volatile Organic Compounds (μg/L)									
Acetone	GDIGW001	9	ND	5	ND	NT	NT	370	NA
	GDIGW002	9	ND	ND	ND	NT	NT		
	GDIGW003	60	ND	ND	ND	NT	NT		
	GDIGW005	10	ND	ND	ND	NT	NT		
	GDIGW006	7	ND	ND	ND	NT	NT		
	GDIGW010	ND	ND	4800	ND	NT	NT		
	GDIGW013	19	ND	ND	ND	NT	ND		
	GDIGW014	ND	10	ND	ND	NT	NT		
	GDIGW016	ND	64	ND	ND	NT	NT		
2-Butanone (MEK)	GDIGW010	ND	3	ND	ND	NT	NT	190	NA
	GDIGW016	ND	3	ND	ND	NT	NT		
Carbon disulfide	GDIGW005	ND	ND	1	ND	NT	NT	100	NA
	GDIGW006	ND	ND	1.5	3	NT	NT		
	GDIGW011	9	ND	2	ND	NT	NT		
	GDIGW019	ND	ND	13	ND	NT	NT		
Chlorobenzene	GDIGW014	2	ND	ND	ND	NT	NT	3.5	NA
1,1-Dichloroethane	GDIGW011	2	1	ND	ND	NT	NT	80	NA
1,2-Dichloroethane (EDC)	GDIGW013	ND	ND	ND	2	NT	ND	0.12	5
1,2-Dichloroethene (total)	GDIGW011	2	7	5	4	NT	NT	5.5	NA
	GDIGW013	ND	ND	ND	ND	NT	2		

Table 10.14.8
Grid-Based Wells
Analytes Detected in Shallow Groundwater

Parameters	Location	1st Round	2nd Round	3rd Round	4th Round	5th Round	6th Round	Tap Water RBC*	MCL/SMCL*
Ethylbenzene	GDIGW012	ND	2	ND	ND	NT	NT	130	700
	GDIGW016	3	ND	ND	ND	NT	NT		
Methylene chloride	GDIGW012	ND	28	ND	ND	NT	NT	4.1	NA
	GDIGW016	ND	27	ND	ND	NT	NT		
4-Methyl-2-Pentanone (MIBK)	GDIGW007	ND	ND	ND	4	NT	ND	290	NA
1,1,2,2-Tetrachloroethane	GDIGW007	ND	ND	ND	1	NT	ND	0.053	NA
Tetrachloroethene (PCE)	GDIGW011	4	1	ND	4	NT	NT	1.1	5
Toluene	GDIGW004	ND	2	ND	ND	NT	NT	75	1000
	GDIGW008	ND	2	ND	ND	NT	ND		
	GDIGW011	ND	2	ND	ND	NT	NT		
	GDIGW012	ND	9	ND	ND	NT	NT		
Trichloroethene (TCE)	GDIGW011	6	4	10	12	NT	NT	1.6	5
Xylene (total)	GDIGW008	ND	2	ND	ND	NT	ND	1200	10000
	GDIGW012	ND	10	ND	ND	NT	NT		
	GDIGW016	6	ND	ND	ND	NT	NT		
	GDIGW019	ND	ND	2	ND	NT	NT		
Semivolatile Organic Compounds (μg/L)									
Acenaphthene	GDIGW006	2	3.5	5.5	3.5	NT	NT	220	NA
	GDIGW011	10	11	6	6	NT	NT		
	GDIGW012	ND	ND	ND	4	NT	NT		
	GDIGW014	7	17	10	13	NT	NT		
	GDIGW015	ND	ND	3	4	NT	NT		
	GDIGW017	ND	2	3	4	NT	NT		

Table 10.14.8
Grid-Based Wells
Analytes Detected in Shallow Groundwater

Parameters	Location	1st Round	2nd Round	3rd Round	4th Round	5th Round	6th Round	Tap Water RBC*	MCL/SMCL*
Acetophenone	GDIGW003	1	ND	ND	ND	NT	NT	0.0042	NA
	GDIGW016	1	ND	ND	ND	NT	NT		
	GDIGW019	1	ND	ND	ND	NT	NT		
Benzoic acid	GDIGW002	ND	ND	ND	1	NT	NT	15000	NA
	GDIGW006	ND	2	2	ND	NT	NT		
	GDIGW009	ND	2	3	ND	NT	NT		
	GDIGW010	ND	1	ND	ND	NT	NT		
	GDIGW011	2	ND	1	ND	NT	NT		
	GDIGW013	ND	ND	2	2	ND	ND		
	GDIGW015	ND	ND	ND	1	NT	NT		
	GDIGW018	ND	ND	2	1	NT	NT		
	GDIGW019	ND	ND	1	1	NT	NT		
Dibenzofuran	GDIGW011	6	5	3	2	NT	NT	2.4	NA
	GDIGW014	1	4	1	ND	NT	NT		
Di-n-butylphthalate	GDIGW004	3	ND	ND	ND	NT	NT	370	NA
	GDIGW018	ND	1	ND	ND	NT	NT		
Diethylphthalate	GDIGW015	ND	2	ND	ND	NT	NT	2900	NA
2,4-Dimethylphenol	GDIGW011	ND	6	ND	2	NT	NT	73	NA
	GDIGW014	ND	1	ND	ND	NT	NT		
bis(2-Ethylhexyl)phthalate (BEHP)	GDIGW001	15	ND	ND	ND	NT	NT	4.8	NA
	GDIGW002	ND	ND	2	ND	NT	NT		
	GDIGW007	ND	ND	11	ND	ND	ND		

Table 10.14.8
Grid-Based Wells
Analytes Detected in Shallow Groundwater

Parameters	Location	1st Round	2nd Round	3rd Round	4th Round	5th Round	6th Round	Tap Water RBC*	MCL/SMCL*
Fluorene	GDIGW006	ND	1	1	2	NT	NT	150	NA
	GDIGW011	6	6	4	3	NT	NT		
	GDIGW014	2	6	3	4	NT	NT		
1-Methylnaphthalene	GDIGW011	10	ND	ND	ND	NT	NT	150	NA
	GDIGW014	6	ND	ND	ND	NT	NT		
2-Methylnaphthalene	GDIGW011	9	5	ND	2	NT	NT	150	NA
	GDIGW014	1	7	2	ND	NT	NT		
3-Methylphenol (m-cresol)	GDIGW011	19	ND	ND	ND	NT	NT	180	NA
4-Methylphenol (p-cresol)	GDIGW011	19	3	ND	ND	NT	NT	18	NA
Naphthalene	GDIGW011	23	18	3	6	NT	NT	150	NA
	GDIGW014	28	93	31	15	NT	NT		
	GDIGW016	ND	2	ND	ND	NT	NT		
	GDIGW017	ND	13	6	14	NT	NT		
Pentachlorophenol	GDIGW014	ND	1	ND	ND	NT	NT	0.56	1
Phenanthrene	GDIGW011	9	4	3	2	NT	NT	110	NA
	GDIGW014	ND	1	ND	ND	NT	NT		
1,2,3,4-Tetrachlorobenzene	GDIGW014	1	ND	ND	ND	NT	NT	0.18	NA
1,2,4-Trichlorobenzene	GDIGW014	4	ND	ND	ND	NT	NT	19	70
2,4,6-Trichlorophenol	GDIGW013	ND	2	ND	ND	ND	ND	6.1	NA
Pesticides and PCBs (μg/l)									
Aroclor-1260	GDIGW014	1.3	ND	ND	ND	NT	NT	0.033	0.5

Table 10.14.8
Grid-Based Wells
Analytes Detected in Shallow Groundwater

Parameters	Location	1st Round	2nd Round	3rd Round	4th Round	5th Round	6th Round	Tap Water RBC*	MCL/SMCL*
beta-BHC (beta-HCH)	GDIGW008	0.022	ND	ND	ND	ND	ND	0.037	NA
	GDIGW015	**0.1**	ND	ND	ND	NT	NT		
	GDIGW016	0.073	ND	ND	ND	NT	NT		
	GDIGW018	**7.1**	ND	ND	ND	NT	NT		
gamma-BHC (Lindane)	GDIGW011	0.62	ND	ND	ND	NT	NT	0.052	0.2
Dieldrin	GDIGW010	5.1	ND	ND	ND	NT	NT	0.0042	NA
Endosulfan II	GDIGW010	1.6	ND	ND	ND	NT	NT	22	NA
Endosulfan sulfate	GDIGW010	2.1	ND	ND	ND	NT	NT	22	NA
Endrin aldehyde	GDIGW010	1.7	ND	ND	ND	NT	NT	1.1	2
Heptachlor	GDIGW001	0.002	ND	ND	ND	NT	NT	0.0023	0.4
Organophosphate Pesticides (μg/l)									
Methyl parathion	GDIGW015	0.24	ND	ND	ND	NT	NT	0.91	NA
Parathion	GDIGW008	0.17	ND	ND	ND	NT	NT	22	NA
Phorate	GDIGW009	0.26	ND	ND	ND	NT	NT	0.73	NA
Herbicides (μg/L)									
4,4'-DDE	GDIGW010	**1.5**	ND	ND	ND	NT	NT	0.2	NA
4,4'-DDT	GDIGW010	14	ND	ND	ND	NT	NT	0.2	NA
Dioxin Compounds (pg/l)									
2,3,7,8-TCDD equivalents (TEQs)	GDIGW002	0.485	0.077	ND	ND	NT	NT	450	30,000
	GDIGW003	0.076	0.009	1.76	4.31	NT	NT		
	GDIGW004	0.228	0.088	1.55	0.033	NT	NT		
	GDIGW008	0.558	ND	ND	ND	NT	NT		

Table 10.14.8
Grid-Based Wells
Analytes Detected in Shallow Groundwater

Parameters	Location	1st Round	2nd Round	3rd Round	4th Round	5th Round	6th Round	Tap Water RBC*	MCL/SMCL*
2,3,7,8-TCDD equivalents (TEQs) (Continued)	GDIGW009	0.345	ND	ND	ND	NT	NT		
	GDIGW010	ND	0.089	0.036	ND	NT	NT		
	GDIGW012	0.376	ND	ND	ND	NT	NT		
	GDIGW015	0.682	ND	ND	0.088	NT	NT		
	GDIGW019	0.97	ND	ND	0.003	NT	NT		
123678-HxCDD	GDIGW003	ND	ND	ND	6.34	NT	NT	4500	NA
1234678-HpCDD	GDIGW003	ND	ND	ND	10	NT	NT	45000	NA
	GDIGW008	4.49	ND	ND	ND	NT	NT		
	GDIGW012	3.56	ND	ND	ND	NT	NT		
	GDIGW015	2.67	ND	ND	ND	NT	NT		
	GDIGW019	4.3	ND	ND	ND	NT	NT		
OCDD	GDIGW002	10.2	6.54	ND	ND	NT	NT	450000	NA
	GDIGW003	8.75	8.9	ND	30.6	NT	NT		
	GDIGW004	22.1	42.2	19.4	32.8	NT	NT		
	GDIGW008	43.2	ND	ND	ND	NT	NT		
	GDIGW009	27.7	ND	ND	ND	NT	NT		
	GDIGW010	ND	8.48	ND	ND	NT	NT		
	GDIGW012	17.7	ND	ND	ND	NT	NT		
	GDIGW015	13.7	ND	ND	ND	NT	NT		
	GDIGW019	21.2	ND	ND	3.29	NT	NT		

Table 10.14.8
Grid-Based Wells
Analytes Detected in Shallow Groundwater

Parameters	Location	1st Round	2nd Round	3rd Round	4th Round	5th Round	6th Round	Tap Water RBC*	MCL/SMCL*
123478-HxCDF	GDIGW003	ND	ND	13.1	ND	NT	NT	4500	NA
	GDIGW004	ND	ND	10.8	ND	NT	NT		
123678-HxCDF	GDIGW003	ND	ND	ND	8.4	NT	NT	4500	NA
123789-HxCDF	GDIGW009	2.93	ND	ND	ND	NT	NT	4500	NA
	GDIGW015	3.81	ND	ND	ND	NT	NT		
	GDIGW019	4.92	ND	ND	ND	NT	NT		
234678-HxCDF	GDIGW003	ND	ND	ND	8.54	NT	NT	4500	NA
1234678-HpCDF	GDIGW002	36.94	6.39	ND	ND	NT	NT	45000	NA
	GDIGW003	5.65	ND	41.7	80.2	NT	NT		
	GDIGW004	16.7	3.81	41.9	ND	NT	NT		
	GDIGW008	5.76	ND	ND	ND	NT	NT		
	GDIGW009	2.14	ND	ND	ND	NT	NT		
	GDIGW010	ND	7.46	3.56	ND	NT	NT		
	GDIGW015	1.93	ND	ND	8.08	NT	NT		
	GDIGW019	2.74	ND	ND	ND	NT	NT		
OCDF	GDIGW002	106	6.8	ND	ND	NT	NT	450000	NA
	GDIGW003	10.5	ND	34	153	NT	NT		
	GDIGW004	39.4	8.23	29.2	ND	NT	NT		
	GDIGW008	8.19	ND	ND	ND	NT	NT		
	GDIGW009	3.41	ND	ND	ND	NT	NT		
	GDIGW010	ND	6.08	ND	ND	NT	NT		
	GDIGW012	2.5	ND	ND	ND	NT	NT		
	GDIGW015	1.55	ND	ND	7.68	NT	NT		

Table 10.14.8
Grid-Based Wells
Analytes Detected in Shallow Groundwater

Parameters	Location	1st Round	2nd Round	3rd Round	4th Round	5th Round	6th Round	Tap Water RBC*	MCL/SMCL*
Inorganics (μg/L)									
Aluminum (Al)	GDIGW001	ND	274	ND	155	NT	NT	3700	NL
	GDIGW003	ND	141	ND	67.8	NT	NT		
	GDIGW004	1190	1550	814	1440	NT	NT		
	GDIGW007	ND	52.4	ND	ND	ND	141		
	GDIGW008	451	55.4	40.2	ND	543	ND		
	GDIGW011	ND	38.9	ND	ND	NT	NT		
	GDIGW014	ND	ND	37.6	ND	NT	NT		
	GDIGW015	ND	57.8	25.1	ND	NT	NT		
	GDIGW016	ND	ND	33.7	ND	NT	NT		
	GDIGW018	ND	42.8	139	62.9	NT	NT		
	GDIGW019	341	257.5	ND	32.1	NT	NT		
Antimony (Sb)	GDIGW002	ND	ND	3.1	ND	NT	NT	1.5	6
	GDIGW003	ND	ND	**3.1**	ND	NT	NT		
	GDIGW006	ND	ND	**3.1**	**8.4**	NT	NT		
	GDIGW008	ND	ND	**5.6**	ND	ND	ND		
	GDIGW011	ND	ND	**6.1**	ND	NT	NT		
	GDIGW015	ND	**5.5**	ND	ND	NT	NT		
Arsenic (As)	GDIGW001	ND	**9.8**	**11.7**	**6.5**	NT	NT	0.045	50
	GDIGW002	**6.4**	**10.4**	**11.9**	**5.4**	NT	NT		
	GDIGW003	ND	ND	**2.9**	**4.9**	NT	NT		
	GDIGW004	**10**	**19.2**	**22.1**	ND	NT	NT		

Table 10.14.8
Grid-Based Wells
Analytes Detected in Shallow Groundwater

Parameters	Location	1st Round	2nd Round	3rd Round	4th Round	5th Round	6th Round	Tap Water RBC*	MCL/SMCL*
Arsenic (As) (Continued)	GDIGW006	ND	ND	**4.8**	**5.8**	NT	NT		
	GDIGW007	ND	ND	ND	**3.8**	ND	ND		
	GDIGW008	ND	ND	ND	ND	**9**	**6.5**		
	GDIGW009	**23**	**31**	**18.2**	**23**	NT	NT		
	GDIGW010	ND	ND	**5.1**	ND	NT	NT		
	GDIGW011	16.1	ND	ND	ND	NT	NT		
	GDIGW013	**9.7**	**12**	**19**	**23.8**	ND	**23.9**		
	GDIGW014	ND	**12.4**	**11.1**	ND	NT	NT		
	GDIGW017	**20.9**	**66.3**	**33.5**	**46.2**	NT	NT		
	GDIGW019	ND	**12.85**	**10.75**	**21.25**	NT	NT		
Barium (Ba)	GDIGW001	38	38.7	ND	36.1	NT	NT	260	2000
	GDIGW002	102	68.1	ND	87.6	NT	NT		
	GDIGW003	78.6	81.5	ND	101	NT	NT		
	GDIGW004	33.7	33.4	ND	39.2	NT	NT		
	GDIGW005	124	147	ND	120	NT	NT		
	GDIGW006	66.9	57.6	ND	65.05	NT	NT		
	GDIGW007	83.7	58	ND	82.3	54.2	NT		
	GDIGW008	35.45	31.2	36.5	42.7	24.9	23.9		
	GDIGW009	60.8	46.9	ND	57.7	NT	NT		
	GDIGW010	34.4	34.7	ND	25.3	NT	NT		
	GDIGW011	**278**	140	163	153	NT	NT		
	GDIGW012	20.6	8.3	12.6	25.3	NT	NT		

Table 10.14.8
Grid-Based Wells
Analytes Detected in Shallow Groundwater

Parameters	Location	1st Round	2nd Round	3rd Round	4th Round	5th Round	6th Round	Tap Water RBC*	MCL/SMCL*
Barium (Ba) (Continued)	GDIGW013	37.8	50.9	47.7	37.4	ND	56.2		
	GDIGW014	18	15.5	18.2	15.4	NT	NT		
	GDIGW015	12.5	30.6	52.7	51.2	NT	NT		
	GDIGW016	7.1	2.5	ND	4.8	NT	NT		
	GDIGW017	18.7	20.8	15.3	19.1	NT	NT		
	GDIGW018	83.1	18.6	19.1	21.3	NT	NT		
	GDIGW019	29.9	20	ND	20.5	NT	NT		
Beryllium (Be)	GDIGW002	ND	ND	0.73	ND	NT	NT	7.3	4
	GDIGW003	ND	ND	0.96	ND	NT	NT		
	GDIGW005	ND	ND	0.98	ND	NT	NT		
	GDIGW006	ND	1.1	0.94	ND	NT	NT		
	GDIGW010	ND	ND	1	ND	NT	NT		
	GDIGW011	ND	1	1.2	ND	NT	NT		
	GDIGW013	ND	ND	ND	0.46	ND	ND		
	GDIGW014	ND	ND	ND	0.32	NT	NT		
Cadmium (Cd)	GDIGW002	0.76	ND	ND	ND	NT	NT	1.8	5
	GDIGW007	ND	2.3	ND	ND	0.45	ND		
	GDIGW009	0.43	ND	ND	ND	NT	NT		
Chromium (Cr) (total)	GDIGW001	1.1	ND	ND	5.7	NT	NT	18	100
	GDIGW002	ND	ND	0.94	ND	NT	NT		
	GDIGW003	2.3	ND	1.5	1.5	NT	NT		
	GDIGW004	4	3.4	ND	7.1	NT	NT		

Table 10.14.8
Grid-Based Wells
Analytes Detected in Shallow Groundwater

Parameters	Location	1st Round	2nd Round	3rd Round	4th Round	5th Round	6th Round	Tap Water RBC*	MCL/SMCL*
Chromium (Cr) (total) (Continued)	GDIGW005	1.9	ND	23.8	NT	NT	NT		
	GDIGW006	1.9	1.25	1.7	2.2	NT	NT		
	GDIGW007	7	ND	ND	1.5	ND	12.1		
	GDIGW008	3.35	ND	ND	ND	ND	22.7		
	GDIGW009	1.7	ND	1.2	1.3	NT	NT		
	GDIGW010	2.8	ND	2.1	0.9	NT	NT		
	GDIGW011	6.9	2.1	5.2	14.3	NT	NT		
	GDIGW012	3.65	ND	ND	ND	NT	NT		
	GDIGW013	ND	ND	ND	ND	ND	13.4		
	GDIGW018	8.1	1.8	ND	ND	NT	NT		
	GDIGW019	3.5	1	ND	ND	NT	NT		
Cobalt (Co)	GDIGW001	0.7	ND	ND	ND	NT	NT	220	NL
	GDIGW002	2.1	4.2	ND	ND	NT	NT		
	GDIGW003	1	ND	ND	ND	NT	NT		
	GDIGW004	1.2	ND	ND	ND	NT	NT		
	GDIGW006	0.96	ND	ND	2.2	NT	NT		
	GDIGW007	0.66	ND	ND	ND	1	ND		
	GDIGW008	ND	ND	ND	ND	1.3	ND		
Copper (Cu)	GDIGW001	1.6	ND	ND	ND	NT	NT	150	1300
	GDIGW004	2.5	4.4	5.2	ND	NT	NT		
	GDIGW006	ND	ND	1.6	ND	NT	NT		
	GDIGW007	1.3	ND	ND	ND	ND	ND		

Table 10.14.8
Grid-Based Wells
Analytes Detected in Shallow Groundwater

Parameters	Location	1st Round	2nd Round	3rd Round	4th Round	5th Round	6th Round	Tap Water RBC*	MCL/SMCL*
Copper (Cu) (Continued)	GDIGW014	3.2	ND	ND	ND	NT	NT		
	GDIGW015	1.33	ND	ND	ND	NT	NT		
	GDIGW019	1.2	ND	ND	ND	NT	NT		
Cyanide	GDIGW005	15.6	ND	ND	ND	NT	NT	73	200
	GDIGW006	21.9	ND	5.4	16.7	NT	NT		
	GDIGW007	35.2	ND	ND	ND	ND	ND		
	GDIGW009	25.2	ND	ND	ND	NT	NT		
	GDIGW011	ND	ND	ND	4.7	NT	NT		
	GDIGW019	ND	ND	ND	3	NT	NT		
Lead (Pb)	GDIGW001	8.5	ND	4.7	ND	NT	NT	15	15
	GDIGW002	15.6	ND	ND	ND	NT	NT		
	GDIGW003	2.7	ND	ND	ND	NT	NT		
	GDIGW004	3.9	ND	ND	4.2	NT	NT		
	GDIGW005	1.9	ND	ND	ND	NT	NT		
	GDIGW006	2.6	ND	ND	2.1	NT	NT		
	GDIGW007	12.7	15.7	ND	ND	ND	ND		
	GDIGW008	4.1	ND	ND	ND	ND	ND		
	GDIGW010	3.6	ND	ND	ND	NT	NT		
	GDIGW011	ND	4	ND	13	NT	NT		
	GDIGW012	3.9	ND	ND	ND	NT	NT		
	GDIGW013	2	ND	ND	ND	ND	ND		
	GDIGW014	2.4	ND	ND	ND	NT	NT		

Table 10.14.8
Grid-Based Wells
Analytes Detected in Shallow Groundwater

Parameters	Location	1st Round	2nd Round	3rd Round	4th Round	5th Round	6th Round	Tap Water RBC*	MCL/SMCL*
Lead (Pb) (Continued)	GDIGW015	3	ND	ND	ND	NT	NT		
	GDIGW016	2.9	ND	ND	ND	NT	NT		
	GDIGW017	3.4	ND	ND	ND	NT	NT		
	GDIGW019	3.3	ND	ND	ND	NT	NT		
Manganese (Mn)	GDIGW001	3060	2920	3230	1280	NT	NT	73	NL
	GDIGW002	1470	2580	1860	1300	NT	NT		
	GDIGW003	616	543	509	409	NT	NT		
	GDIGW004	546	736	913	735	NT	NT		
	GDIGW005	360	277	186	167	NT	NT		
	GDIGW006	102	93	91.4	99.8	NT	NT		
	GDIGW007	824	646	634	544	1240	718		
	GDIGW008	1605	1720	1670	917	2550	1480		
	GDIGW009	4525	3560	2830	3560	NT	NT		
	GDIGW010	130	1300	ND	280	NT	NT		
	GDIGW011	172	92.7	160	144	NT	NT		
	GDIGW012	97.8	44.3	62.7	65.6	NT	NT		
	GDIGW013	236	148	176	134	ND	126		
	GDIGW014	512	790	832	448	NT	NT		
	GDIGW015	51.2	181	192	207	NT	NT		
	GDIGW016	98.6	133	93.1	172.5	NT	NT		
	GDIGW017	445	369	372	272	NT	NT		
	GDIGW018	23.4	36.6	41.7	46.2	NT	NT		
	GDIGW019	663	1040	801	663.5	NT	NT		

Table 10.14.8
Grid-Based Wells
Analytes Detected in Shallow Groundwater

Parameters	Location	1st Round	2nd Round	3rd Round	4th Round	5th Round	6th Round	Tap Water RBC*	MCL/SMCL*
Mercury (Hg)	GDIGW001	ND	1.1	ND	ND	NT	NT	1.1	2
	GDIGW017	ND	ND	ND	0.12	NT	NT		
Nickel (Ni)	GDIGW001	4.9	4.6	ND	3	NT	NT	73	100
	GDIGW002	4.4	16.3	12.8	1.6	NT	NT		
	GDIGW003	2	ND	1.3	ND	NT	NT		
	GDIGW004	4.9	6.8	ND	10.1	NT	NT		
	GDIGW005	ND	ND	10.7	ND	NT	NT		
	GDIGW006	ND	ND	1.4	1.3	NT	NT		
	GDIGW007	3.8	1.1	ND	ND	ND	ND		
	GDIGW008	2.3	1.9	ND	ND	9.7	ND		
	GDIGW009	ND	1	ND	1	NT	NT		
	GDIGW010	ND	1	ND	ND	NT	NT		
	GDIGW011	3.6	1.2	3.3	8.7	NT	NT		
	GDIGW012	2	1.1	ND	ND	NT	NT		
	GDIGW013	ND	2.4	ND	ND	ND	ND		
	GDIGW014	1.5	ND	ND	ND	NT	NT		
	GDIGW015	3.4	ND	1.3	2.3	NT	NT		
	GDIGW016	ND	ND	ND	1.1	NT	NT		
	GDIGW017	ND	1.7	ND	4.9	NT	NT		
	GDIGW018	ND	1.1	ND	ND	NT	NT		
	GDIGW019	3.5	6.2	7.3	11.6	NT	NT		
Selenium (Se)	GDIGW007	ND	ND	ND	ND	ND	26.7	18	50

Table 10.14.8
Grid-Based Wells
Analytes Detected in Shallow Groundwater

Parameters	Location	1st Round	2nd Round	3rd Round	4th Round	5th Round	6th Round	Tap Water RBC*	MCL/SMCL*
Silver (Ag)	GDIGW006	ND	ND	ND	4.6	NT	NT	18	NL
	GDIGW018	ND	ND	ND	1.3	NT	NT		
Thallium (Tl)	GDIGW001	ND	ND	**5.5**	ND	NT	NT	0.26	2
	GDIGW002	ND	**6.6**	**3.5**	ND	NT	NT		
	GDIGW003	ND	ND	**2.8**	ND	NT	NT		
	GDIGW005	ND	ND	**3**	ND	NT	NT		
	GDIGW009	ND	**7.5**	ND	ND	NT	NT		
	GDIGW011	ND	ND	ND	**4.1**	NT	NT		
	GDIGW012	ND	**5.9**	ND	ND	NT	NT		
	GDIGW017	ND	**5.4**	ND	ND	NT	NT		
	GDIGW019	ND	**5.9**	ND	**3.5**	NT	NT		
Tin (Sn)	GDIGW001	ND	ND	ND	2.7	NT	NT	2200	NL
	GDIGW003	ND	ND	ND	2.9	NT	NT		
	GDIGW006	ND	ND	ND	3.3	NT	NT		
	GDIGW010	ND	ND	ND	3.3	NT	NT		
Vanadium (V)	GDIGW001	1.3	9.8	6.5	11.3	NT	NT	26	NL
	GDIGW002	2.3	1.2	2.9	ND	NT	NT		
	GDIGW003	1.3	2.5	5.4	ND	NT	NT		
	GDIGW004	3.3	4	ND	ND	NT	NT		
	GDIGW005	2.6	3.3	4.6	ND	NT	NT		
	GDIGW006	2.7	3.3	5	7.3	NT	NT		
	GDIGW007	4.4	2.6	ND	ND	ND	ND		

Table 10.14.8
Grid-Based Wells
Analytes Detected in Shallow Groundwater

Parameters	Location	1st Round	2nd Round	3rd Round	4th Round	5th Round	6th Round	Tap Water RBC*	MCL/SMCL*
Vanadium (V) (Continued)	GDIGW008	3.65	1.7	ND	5.8	ND	ND		
	GDIGW009	2.6	2	1.3	ND	NT	NT		
	GDIGW010	4	3	ND	ND	NT	NT		
	GDIGW011	10.9	18.8	8.3	13.9	NT	NT		
	GDIGW012	0.44	ND	ND	ND	NT	NT		
	GDIGW013	0.67	ND	ND	ND	ND	ND		
	GDIGW014	ND	1.3	ND	ND	NT	NT		
	GDIGW015	ND	1.4	ND	ND	NT	NT		
	GDIGW017	ND	5	ND	ND	NT	NT		
	GDIGW018	ND	5.4	ND	5.4	NT	NT		
	GDIGW019	3.3	2.25	ND	2.35	NT	NT		
Zinc (Zn)	GDIGW001	7.1	ND	ND	ND	NT	NT	1100	NL
	GDIGW002	11.3	ND	ND	ND	NT	NT		
	GDIGW003	18	ND	ND	ND	NT	NT		
	GDIGW004	16.7	6.2	ND	10	NT	NT		
	GDIGW005	11.4	ND	ND	ND	NT	NT		
	GDIGW006	15.7	ND	ND	ND	NT	NT		
	GDIGW007	20.9	ND	ND	ND	ND	ND		
	GDIGW008	20.3	ND	ND	ND	24.5	316		
	GDIGW009	9.35	ND	ND	ND	NT	NT		
	GDIGW010	10.9	ND	ND	ND	NT	NT		
	GDIGW011	24.2	ND	ND	ND	NT	NT		

Table 10.14.8
Grid-Based Wells
Analytes Detected in Shallow Groundwater

Parameters	Location	1st Round	2nd Round	3rd Round	4th Round	5th Round	6th Round	Tap Water RBC*	MCL/SMCL*
Zinc (Zn) (Continued)	GDIGW012	15.6	ND	ND	ND	NT	NT		
	GDIGW013	7.3	4.8	ND	ND	ND	ND		
	GDIGW014	15.4	ND	ND	24.4	NT	NT		
	GDIGW015	16.5	4.1	ND	21	NT	NT		
	GDIGW016	9.4	ND	ND	13.9	NT	NT		
	GDIGW017	11.1	11.1	ND	14.3	NT	NT		
	GDIGW018	12.2	ND	ND	ND	NT	NT		
	GDIGW019	53.4	ND	ND	ND	NT	NT		

Notes:
* = Tap Water RBCs (THQ=0.1) from *Risk-Based Concentration Table* (USEPA, October 22, 1997), and MCLs/SMCLs from *Drinking Water Regulations and Health Advisories* (USEPA, 1996e)
Bolded concentrations exceed the RBCs, or SSL
NA = Not applicable/not available
ND = Not detected
NI = Not installed
NL = Not listed
NT = Not taken
RBC = Risk-based concentration
SSL = Soil screening level
ng/kg = Nanograms per kilogram
μg/kg = Micrograms per kilogram
pg/l = Micrograms per liter
μg/l = Micrograms per liter
mg/kg = Milligrams per kilogram
mg/l = Milligrams per liter

Table 10.14.9
Grid-Based Locations
Organic Compound Analytical Results for Deep Groundwater (μg/L)

Parameter	Sample Round	Detection Frequency	Detection Range	Mean	Tap-Water RBC/MCL	Number of Samples Exceeding Lower of RBC or MCL
Volatile Organic Compounds						
2-Butanone	First	0/19	ND	ND	190/NA	0
	Second	1/19	2.0	2.0		0
	Third	1/19	4.0	4.0		0
	Fourth	0/19	ND	ND		0
	Fifth	0/0	NA	NA		0
	Sixth	0/3	ND	ND		0
Acetone	First	2/19	21.0 - 27.0	24.0	370/NA	0
	Second	0/19	ND	ND		0
	Third	0/19	ND	ND		0
	Fourth	1/19	30.0	30.0		0
	Fifth	0/0	NA	NA		0
	Sixth	0/3	ND	ND		0
Benzene	First	0/19	ND	ND	0.36/5.0	0
	Second	1/19	1.0	1.0		1
	Third	0/19	ND	ND		0
	Fourth	0/19	ND	ND		0
	Fifth	0/0	NA	NA		0
	Sixth	0/3	ND	ND		0
Carbon Disulfide	First	2/19	1.0 - 1.0	1.0	100/NA	0
	Second	1/19	8.0	8.0		0
	Third	2/19	1.0 - 2.0	1.5		0
	Fourth	1/19	1.0	1.0		0
	Fifth	1/3	0.95	0.95		0
	Sixth	0/3	ND	ND		0
Chloroethane	First	2/19	5.0 - 6.0	5.5	3.6/NA	2
	Second	0/19	ND	ND		0
	Third	0/19	ND	ND		0
	Fourth	1/19	200	200		0
	Fifth	0/0	NA	NA		0
	Sixth	0/3	ND	ND		0
Methylene chloride	First	1/19	3.0	3.0	4.1/NA	0
	Second	0/19	ND	ND		0
	Third	0/19	ND	ND		0
	Fourth	0/19	ND	ND		0
	Fifth	0/0	NA	NA		0
	Sixth	0/3	ND	ND		0
Toluene	First	0/19	ND	ND	75/1,000	0
	Second	1/19	1.0	1.0		0
	Third	0/19	ND	ND		0
	Fourth	0/19	ND	ND		0
	Fifth	0/0	NA	NA		0
	Sixth	0/3	ND	ND		0

Table 10.14.9
Grid-Based Locations
Organic Compound Analytical Results for Deep Groundwater (µg/L)

Parameter	Sample Round	Detection Frequency	Detection Range	Mean	Tap-Water RBC/MCL	Number of Samples Exceeding Lower of RBC or MCL
Xylene (Total)	First	0/19	ND	ND	1,200/10,000	0
	Second	1/19	2.0	2.0		0
	Third	0/19	ND	ND		0
	Fourth	0/19	ND	ND		0
	Fifth	0/0	NA	NA		0
	Sixth	0/3	ND	ND		0
Semivolatile Organic Compounds						
2-Methyphenol (o-Cresol)	First	1/19	50.0	50.0	180/NA	0
	Second	1/19	44.0	44.0		0
	Third	1/19	3.0	3.0		0
	Fourth	1/19	43.0	43.0		0
	Fifth	0/3	ND	ND		0
	Sixth	0/3	ND	ND		0
2,4-Dimethylphenol	First	2/19	5.0 - 5.5	5.25	73/NA	0
	Second	1/19	8.0	8.0		0
	Third	1/19	2.0	2.0		0
	Fourth	1/19	11.0	11.0		0
	Fifth	0/3	ND	ND		0
	Sixth	0/3	ND	ND		0
Benzoic acid	First	0/19	ND	ND	15,000/NA	0
	Second	8/19	1.0 - 10.0	2.75		0
	Third	9/19	1.0 - 7.0	2.33		0
	Fourth	6/19	1.0 - 5.0	1.83		0
	Fifth	0/3	ND	ND		0
	Sixth	0/3	ND	ND		0
Benzyl Alcohol	First	1/19	83.0	83.0	1,100/NA	0
	Second	0/19	ND	ND		0
	Third	0/19	ND	ND		0
	Fourth	0/19	ND	ND		0
	Fifth	0/3	ND	ND		0
	Sixth	0/3	ND	ND		0
Diethylphthalate	First	0/19	ND	ND	2,900/NA	0
	Second	5/19	2.0 - 2.0	2.0		0
	Third	0/19	ND	ND		0
	Fourth	0/19	ND	ND		0
	Fifth	0/3	ND	ND		0
	Sixth	0/3	ND	ND		0
Butylbenzylphthalate	First	0/19	ND	ND	730/NA	0
	Second	1/19	5.0	5.0		0
	Third	0/19	ND	ND		0
	Fourth	0/19	ND	ND		0
	Fifth	0/3	ND	ND		0
	Sixth	0/3	ND	ND		0

Table 10.14.9
Grid-Based Locations
Organic Compound Analytical Results for Deep Groundwater (μg/L)

Parameter	Sample Round	Detection Frequency	Detection Range	Mean	Tap-Water RBC/MCL	Number of Samples Exceeding Lower of RBC or MCL
Phenol	First	0/19	ND	ND	2,200/NA	0
	Second	2/19	7.0 - 23.0	15.0		0
	Third	0/19	ND	ND		0
	Fourth	0/19	ND	ND		0
	Fifth	0/3	ND	ND		0
	Sixth	0/3	ND	ND		0
bis-(2-Ethylhexyl) phthalate	First	0/19	ND	ND	4.8/NA	0
	Second	1/19	380	380		0
	Third	1/19	1.0	1.0		0
	Fourth	0/19	ND	ND		0
	Fifth	0/3	ND	ND		0
	Sixth	0/3	ND	ND		0
Pesticides and PCBs						
Aroclor-1260	First	1/19	1.0	1.0	0.033/NA	0
	Second	0/19	ND	ND		0
	Third	0/19	ND	ND		0
	Fourth	0/19	ND	ND		0
Aldrin	First	1/19	0.078	0.078	0.0039/NA	1
	Second	0/19	ND	ND		0
	Third	0/19	ND	ND		0
	Fourth	0/19	ND	ND		0
Heptachlor	First	1/19	0.31	0.31	0.0023/0.4	1
	Second	0/19	ND	ND		0
	Third	0/19	ND	ND		0
	Fourth	0/19	ND	ND		0
Alpha-BHC	First	1/19	0.38	0.38	0.011/NA	1
	Second	0/19	ND	ND		0
	Third	0/19	ND	ND		0
	Fourth	0/19	ND	ND		0
Beta-BHC	First	3/19	0.052 - 290	96.7	0.037/NA	3
	Second	0/19	ND	ND		0
	Third	0/19	ND	ND		0
	Fourth	0/19	ND	ND		0
Delta-BHC	First	0/19	ND	ND	0.037/NA	0
	Second	1/19	0.4	0.4		1
	Third	0/19	ND	ND		0
	Fourth	0/19	ND	ND		0
gamma-BHC (Lindane)	First	2/19	0.178 - 0.19	0.184	0.052/0.2	2
	Second	0/19	ND	ND		0
	Third	0/19	ND	ND		0
	Fourth	0/19	ND	ND		0

Table 10.14.9
Grid-Based Locations
Organic Compound Analytical Results for Deep Groundwater (μg/L)

Parameter	Sample Round	Detection Frequency	Detection Range	Mean	Tap-Water RBC/MCL	Number of Samples Exceeding Lower of RBC or MCL
Herbicides						
2,4,5-T	First	1/19	0.02	0.02	37/NA	0
	Second	0/19	ND	ND		0
	Third	0/19	ND	ND		0
	Fourth	0/19	ND	ND		0
2,4,5-TP (silvex)	First	1/19	0.021	0.021	29/50	0
	Second	0/19	ND	ND		0
	Third	0/19	ND	ND		0
	Fourth	0/19	ND	ND		0
Dioxins						
TEQs	First	7/19	1.69E-8 - 7.27E-7	4.75E-7	4.5E-4/3.0E-2	0
	Second	2/19	1.27E-8 - 1.67E-8	1.47E-8		0
	Third	3/19	3.51E-8 - 1.67E-6	6.31E-7		0
	Fourth	0/19	ND	ND		0
1234678-HpCDD	First	4/19	1.40E-6 - 3.49E-6	2.58E-6	4.5E-2/NA	0
	Second	0/19	ND	ND		0
	Third	0/19	ND	ND		0
	Fourth	0/19	ND	ND		0
1234678-HpCDF	First	5/19	1.31E-6 - 1.11E-5	5.31E-6	4.5E-2/NA	0
	Second	0/19	ND	ND		0
	Third	3/19	3.51E-6 - 4.03E-5	2.10E-5		0
	Fourth	0/19	ND	ND		0
1234789-HpCDF	First	1/19	3.51E-6	3.51E-6	4.5E-2/NA	0
	Second	0/19	ND	ND		0
	Third	0/19	ND	ND		0
	Fourth	0/19	ND	ND		0
12378-HxCDF	First	0/19	ND	ND	4.5E-3/NA	0
	Second	0/19	ND	ND		0
	Third	1/19	1.21E-5	1.21E-5		0
	Fourth	0/19	ND	ND		0
123789-HxCDF	First	6/19	2.40E-6 - 5.6E-6	4.64E-6	4.5E-3/NA	0
	Second	0/19	ND	ND		0
	Third	0/19	ND	ND		0
	Fourth	0/19	ND	ND		0
OCDD	First	7/19	4.86 - 16.9	10.7	4.5E-1/NA	0
	Second	1/19	9.51	9.51		0
	Third	1/19	17.3	17.3		0
	Fourth	0/19	ND	ND		0

Table 10.14.9
Grid-Based Locations
Organic Compound Analytical Results for Deep Groundwater (μg/L)

Parameter	Sample Round	Detection Frequency	Detection Range	Mean	Tap-Water RBC/MCL	Number of Samples Exceeding Lower of RBC or MCL
OCDF	First	4/19	1.1 - 27.5	15.4	4.5E-1/NA	0
	Second	2/19	7.17 - 12.7	9.94		0
	Third	1/19	35.9	35.9		0
	Fourth	0/19	ND	ND		0

Notes:
NA = Not Applicable/Not Available
ND = Not Detected/Not Determined
NL = Not Listed
μg/L = micrograms per liter
See Table 5.5 for inorganic screening concentrations and their sources.

Table 10.14.10
Grid-based Locations
Inorganic Analytical Results for Deep Groundwater (μg/L)

Parameters	Sample Round	Detection Frequency	Detection Range	Mean	Tap-water RBC/MCL	Number of Samples Exceeding Lower of RBC or MCL
Aluminum (Al)	First	0/19	ND	ND	3,700/NL	0
	Second	6/19	29.0 - 235	105		0
	Third	3/19	31.4 - 104	59.9		0
	Fourth	2/19	35.5 - 62.3	48.9		0
	Fifth	0/3	ND	ND		0
	Sixth	0/3	ND	ND		0
Antimony (Sb)	First	0/19	ND	ND	1.5/6.0	0
	Second	1/19	4.5	4.5		1
	Third	3/19	5.4 - 6.1	5.77		3
	Fourth	0/19	ND	ND		0
	Fifth	1/3	9.2	9.2		1
	Sixth	0/3	ND	ND		0
Arsenic (As)	First	1/19	14.2	14.2	0.045/50	1
	Second	3/19	5.2 - 13.3	8.57		3
	Third	5/19	3.5 - 11.9	6.62		5
	Fourth	3/19	2.6 - 24.8	10.2		3
	Fifth	1/3	7.4	7.4		1
	Sixth	2/3	2.2 - 2.4	2.3		2
Barium (Ba)	First	18/19	35.7 - 942	186	260/2,000	4
	Second	19/19	27.7 - 763	133		1
	Third	11/19	37.9 - 691	149		0
	Fourth	19/19	27.7 - 475	118		0
	Fifth	2/3	167 - 168	168		0
	Sixth	3/3	98.7 - 168	134		0
Beryllium (Be)	First	0/19	ND	ND	7.3/4	0
	Second	8/19	1.0 - 1.2	1.06		0
	Third	4/19	0.83 - 1.0	0.9		0
	Fourth	2/19	0.87 - 1.0	0.935		0
	Fifth	0/3	ND	ND		0
	Sixth	0/3	ND	ND		0
Cadmium (Cd)	First	2/19	0.3 - 0.3	0.3	1.8/5	0
	Second	1/19	2.5	2.5		0
	Third	0/19	ND	ND		0
	Fourth	1/19	2.0	2.0		0
	Fifth	2/3	0.4 - 0.75	0.575		0
	Sixth	1/3	2.0	2.0		0
Chromium (Cr)	First	13/19	0.94 - 6.8	2.43	18/100	0
	Second	4/19	1.1 - 2.0	1.52		0
	Third	6/19	1.1 - 5.0	2.72		0
	Fourth	7/19	1.4 - 11.7	5.76		0
	Fifth	0/3	ND	ND		0
	Sixth	2/3	17.5 - 49.5	33.5		0
Cobalt (Co)	First	6/19	0.66 - 1.3	0.948	220/NL	0
	Second	0/19	ND	ND		0
	Third	2/19	2.3 - 2.4	2.35		0
	Fourth	0/19	ND	ND		0
	Fifth	1/3	3.6	3.6		0
	Sixth	0/3	ND	ND		0

Table 10.14.10
Grid-based Locations
Inorganic Analytical Results for Deep Groundwater (μg/L)

Parameters	Sample Round	Detection Frequency	Detection Range	Mean	Tap-water RBC/MCL	Number of Samples Exceeding Lower of RBC or MCL
Copper (Cu)	First	5/19	0.79 - 4.2	1.86	150/1,300	0
	Second	0/19	ND	ND		0
	Third	2/19	0.99 - 4.3	2.64		0
	Fourth	1/19	15.4	15.4		0
	Fifth	0/3	ND	ND		0
	Sixth	0/3	ND	ND		0
Cyanide (CN)	First	4/19	23.1 - 329	102	73/200	1
	Second	4/19	7.8 - 16.6	11.6		0
	Third	1/3	6.0	6.0		0
	Fourth	0/19	ND	ND		0
	Fifth	0/3	ND	ND		0
	Sixth	0/3	ND	ND		0
Lead (Pb)	First	619	2.2 - 26.2	7.35	15/15	1
	Second	1/19	8.9	8.9		0
	Third	0/19	ND	ND		0
	Fourth	2/19	3.6 - 51.4	27.5		1
	Fifth	0/3	ND	ND		0
	Sixth	0/3	ND	ND		0
Manganese (Mn)	First	19/19	0.42 - 302	137	73/NL	13
	Second	14/19	11.8 - 261	127		9
	Third	14/19	3.3 - 690	169		10
	Fourth	14/19	0.99 - 261	120		9
	Fifth	0/3	ND	ND		0
	Sixth	2/3	24.7 - 29.8	27.3		0
Mercury (Hg)	First	0/19	ND	ND	1.1/2	0
	Second	3/19	0.21 - 1.9	0.803		1
	Third	0/19	ND	ND		0
	Fourth	0/19	ND	ND		0
	Fifth	0/3	ND	ND		0
	Sixth	0/3	ND	ND		0
Nickel (Ni)	First	9/19	1.4 - 454	53.2	73/100	1
	Second	2/19	2.2 - 3.2	2.7		0
	Third	2/19	0.95 - 3.8	2.38		0
	Fourth	6/19	0.87 - 10.1	3.54		0
	Fifth	0/3	ND	ND		0
	Sixth	0/3	ND	ND		0
Selenium (Se)	First	0/19	ND	ND	18/50	0
	Second	0/19	ND	ND		0
	Third	0/19	ND	ND		0
	Fourth	1/19	5.9	5.9		0
	Fifth	0/3	ND	ND		0
	Sixth	0/3	ND	ND		0
Thallium (Tl)	First	0/19	ND	ND	0.26/2	0
	Second	9/19	5.1 - 8.6	6.03		9
	Third	3/19	4.2 - 7.1	5.5		3
	Fourth	4/19	3.1 - 15.4	7.58		4
	Fifth	0/3	ND	ND		0
	Sixth	0/3	ND	ND		0

Table 10.14.10
Grid-based Locations
Inorganic Analytical Results for Deep Groundwater (μg/L)

Parameters	Sample Round	Detection Frequency	Detection Range	Mean	Tap-water RBC/MCL	Number of Samples Exceeding Lower of RBC or MCL
Tin (Sn)	First	7/19	115 - 365	272	2,200/NL	0
	Second	0/19	ND	ND		0
	Third	0/19	ND	ND		0
	Fourth	3/19	3.1 - 3.7	3.3		0
	Fifth	1/3	7.0	7.0		0
	Sixth	0/3	ND	ND		0
Vanadium (V)	First	7/19	1.4 - 5.6	3.44	26/NL	0
	Second	10/19	1.5 - 10.6	4.15		0
	Third	6/19	0.95 - 15.7	6.36		0
	Fourth	8/19	1.4 - 8.7	7.15		0
	Fifth	0/3	ND	ND		0
	Sixth	1/3	14.8	14.8		0
Zinc (Zn)	First	13/19	6.95 - 116	26.3	1,100/NL	0
	Second	0/19	ND	ND		0
	Third	0/19	ND	ND		0
	Fourth	0/19	ND	ND		0
	Fifth	0/3	ND	ND		0
	Sixth	0/3	ND	ND		0

Notes:
NA = Not Applicable/Not Available
ND = Not Detected/Not Determined
NL = Not Listed
μg/L = micrograms per liter
See Table 5.6 for inorganic screening concentrations and their sources.

Table 10.14.11
Grid-Based Wells
Analytes Detected in Deep Groundwater

Parameters	Location	1st Round	2nd Round	3rd Round	4th Round	5th Round	6th Round	Tap Water RBC*	MCL/SMCL*
Volatile Organic Compounds ($\mu g/L$)									
Acetone	GDIGW03D	27	ND	ND	ND	NT	NT	370	NA
	GDIGW14D	21	ND	ND	30	NT	NT		
Benzene	GDIGW12D	ND	1	ND	ND	NT	NT	0.36	5
2-Butanone (MEK)	GDIGW09D	ND	2	ND	ND	NT	NT	190	NA
	GDIGW14D	ND	ND	4	ND	NT	NT		
Carbon disulfide	GDIGW02D	ND	ND	ND	1	NT	NT	100	NA
	GDIGW04D	ND	ND	2	ND	NT	NT		
	GDIGW08D	1	ND	1	ND	NT	ND		
	GDIGW13D	ND	ND	ND	ND	0.95	ND		
	GDIGW14D	ND	8	ND	ND	ND	ND		
	GDIGW17D	1	ND	ND	ND	NT	NT		
Chloroethane	GDIGW13D	6	ND	ND	ND	ND	ND	3.6	NA
	GDIGW14D	ND	ND	ND	**200**	NT	NT		
	GDIGW18D	5	ND	ND	ND	NT	NT		
Methylene chloride	GDIGW14D	3	ND	ND	ND	NT	NT	4.1	NA
Toluene	GDIGW12D	ND	1	ND	ND	NT	NT	75	1000
Xylene (total)	GDIGW03D	ND	2	ND	ND	NT	NT	1200	10000
Semivolatile Organic Compounds ($\mu g/l$)									
Benzoic acid	GDIGW02D	ND	ND	ND	2	NT	NT	15000	NA
	GDIGW03D	ND	1	ND	ND	NT	NT		
	GDIGW05D	ND	2	1	ND	NT	NT		

Table 10.14.11
Grid-Based Wells
Analytes Detected in Deep Groundwater

Parameters	Location	1st Round	2nd Round	3rd Round	4th Round	5th Round	6th Round	Tap Water RBC*	MCL/SMCL*
Benzoic acid (Continued)	GDIGW06D	ND	ND	ND	1	NT	NT		
	GDIGW07D	ND	ND	2	ND	ND	ND		
	GDIGW08D	ND	ND	1	ND	ND	ND		
	GDIGW09D	ND	2	2	ND	NT	NT		
	GDIGW10D	ND	3	ND	ND	NT	NT		
	GDIGW11D	ND	2	ND	ND	NT	NT		
	GDIGW12D	ND	ND	1	1	NT	NT		
	GDIGW13D	ND	ND	2	ND	ND	ND		
	GDIGW14D	ND	10	7	5	ND	ND		
	GDIGW15D	ND	ND	ND	1	ND	ND		
	GDIGW17D	ND	1	3	1	NT	NT		
	GDIGW18D	ND	1	ND	ND	NT	NT		
	GDIGW19D	ND	ND	2	ND	NT	NT		
Benzyl alcohol	GDIGW12D	83	ND	ND	ND	NT	NT	1100	NA
Butylbenzylphthalate	GDIGW05D	ND	5	ND	ND	NT	NT	730	NA
Diethylphthalate	GDIGW03D	ND	2	ND	ND	NT	NT	2900	NA
	GDIGW04D	ND	2	ND	ND	NT	NT		
	GDIGW11D	ND	2	ND	ND	NT	NT		
	GDIGW14D	ND	2	ND	ND	NT	NT		
	GDIGW15D	ND	2	ND	ND	NT	NT		
2,4-Dimethylphenol	GDIGW12D	5.5	8	2	11	NT	NT	73	NA
	GDIGW13D	5	ND	ND	ND	ND	ND		

Table 10.14.11
Grid-Based Wells
Analytes Detected in Deep Groundwater

Parameters	Location	1st Round	2nd Round	3rd Round	4th Round	5th Round	6th Round	Tap Water RBC*	MCL/SMCL*
bis(2-Ethylhexyl)phthalate (BEHP)	GDIGW05D	ND	**380**	ND	ND	NT	NT	4.8	NA
	GDIGW06D	ND	ND	1	ND	NT	NT		
2-Methylphenol (o-cresol)	GDIGW12D	50	44	3	43	NT	NT	180	NA
Naphthalene	GDIGW18D	ND	ND	1	ND	NT	NT	150	NA
Phenol	GDIGW13D	ND	23	ND	ND	ND	ND	2200	NA
	GDIGW14D	ND	7	ND	ND	NT	NT		
Pesticides and PCBs (μg/L)									
Aldrin	GDIGW13D	**0.078**	ND	ND	ND	ND	ND	0.0039	NA
Aroclor-1260	GDIGW01D	ND	**1**	ND	ND	NT	NT	0.033	0.5
alpha-BHC (alpha-HCH)	GDIGW13D	**0.38**	ND	ND	ND	ND	ND	0.011	NA
beta-BHC (beta-HCH)	GDIGW06D	**0.052**	ND	ND	ND	NT	NT	0.037	NA
	GDIGW13D	**0.18**	ND	ND	ND	ND	ND		
	GDIGW19D	**290**	ND	ND	ND	NT	NT		
delta-BHC (delta-HCH)	GDIGW18D	ND	ND	ND	**0.4**	NT	NT	0.037	NA
gamma-BHC (Lindane)	GDIGW13D	0.178	ND	ND	ND	ND	ND	0.052	0.2
	GDIGW19D	0.19	ND	ND	ND	NT	NT		
Heptachlor	GDIGW13D	0.31	ND	ND	ND	NT	NT	0.0023	0.4
Herbicides (μg/L)									
2,4,5-T	GDIGW12D	0.02	ND	ND	ND	NT	NT	37	NA
2,4,5-TP (Silvex)	GDIGW12D	0.021	ND	ND	ND	NT	NT	29	50

Table 10.14.11
Grid-Based Wells
Analytes Detected in Deep Groundwater

Parameters	Location	1st Round	2nd Round	3rd Round	4th Round	5th Round	6th Round	Tap Water RBC*	MCL/SMCL*
Dioxin Compounds (pg/L)									
2,3,7,8-TCDD equivalents (TEQs)	GDIGW01D	0.618	ND	0.192	ND	NT	NT	450	30000
	GDIGW02D	0.456	ND	ND	ND	NT	NT		
	GDIGW03D	0.727							
	GDIGW04D	0.277	0.017	1.67	ND	NT	NT		
	GDIGW06D	0.560	ND	ND	ND	NT	NT		
	GDIGW12D	0.672	ND	ND	ND	NT	NT		
	GDIGW16D	ND	0.013	0.035	ND	NT	NT		
	GDIGW19D	0.017	ND	ND	ND	NT	NT		
1234678-HpCDD	GDIGW01D	3.49	ND	ND	ND	NT	NT	45000	NA
	GDIGW02D	2.19	ND	ND	ND	NT	NT		
	GDIGW03D	3.24	ND	ND	ND	NT	NT		
	GDIGW04D	1.4	ND	ND	ND	NT	NT		
OCDD	GDIGW01D	10.5	ND	ND	ND	NT	NT	450000	NA
	GDIGW02D	8.28	ND	ND	ND	NT	NT		
	GDIGW03D	13.6	ND	ND	ND	NT	NT		
	GDIGW04D	4.86	9.51	17.3	ND	NT	NT		
	GDIGW06D	11.8	ND	ND	ND	NT	NT		
	GDIGW12D	9.3	ND	ND	ND	NT	NT		
	GDIGW19D	16.9	ND	ND	ND	NT	NT		
123478-HxCDF	GDIGW04D	ND	ND	12.1	ND	NT	NT	4500	NA

Table 10.14.11
Grid-Based Wells
Analytes Detected in Deep Groundwater

Parameters	Location	1st Round	2nd Round	3rd Round	4th Round	5th Round	6th Round	Tap Water RBC*	MCL/SMCL*
123789-HxCDF	GDIGW01D	5.01	ND	ND	ND	NT	NT	4500	NA
	GDIGW02D	4.13	ND	ND	ND	NT	NT		
	GDIGW03D	5.6	ND	ND	ND	NT	NT		
	GDIGW04D	2.4	ND	ND	ND	NT	NT		
	GDIGW06D	5.48	ND	ND	ND	NT	NT		
	GDIGW12D	5.25	ND	ND	ND	NT	NT		
1234678-HpCDF	GDIGW01D	3.11	ND	19.2	ND	NT	NT	45000	NA
	GDIGW02D	1.31	ND	ND	ND	NT	NT		
	GDIGW03D	9.32	ND	ND	ND	NT	NT		
	GDIGW04D	1.72	ND	40.3	ND	NT	NT		
	GDIGW12D	11.1	ND	ND	ND	NT	NT		
	GDIGW16D	ND	ND	3.51	ND	NT	NT		
1234789-HpCDF	GDIGW01D	3.51	ND	ND	ND	NT	NT		
OCDF	GDIGW01D	6.03	ND	ND	ND	NT	NT	450000	NA
	GDIGW03D	27.5	ND	ND	ND	NT	NT		
	GDIGW04D	1.1	7.17	35.9	ND	NT	NT		
	GDIGW12D	26.8	ND	ND	ND	NT	NT		
	GDIGW16D	ND	12.7	ND	ND	NT	NT		
Inorganics ($\mu g/L$)									
Aluminum (Al)	GDIGW01D	ND	ND	ND	62.3	NT	NT	3700	NL
	GDIGW03D	ND	235	104	35.5	NT	NT		
	GDIGW04D	ND	45.1	31.4	ND	NT	NT		

Table 10.14.11
Grid-Based Wells
Analytes Detected in Deep Groundwater

Parameters	Location	1st Round	2nd Round	3rd Round	4th Round	5th Round	6th Round	Tap Water RBC*	MCL/SMCL*
Aluminum (Al) (Continued)	GDIGW11D	ND	98.8	ND	ND	NT	NT		
	GDIGW14D	ND	29	ND	ND	NT	NT		
	GDIGW17D	ND	43.9	44.2	ND	NT	NT		
	GDIGW18D	ND	180	ND	ND	NT	NT		
Antimony (Sb)	GDIGW03D	ND	4.5	6.1	ND	NT	NT	1.5	6
	GDIGW05D	ND	ND	5.8	ND	NT	NT		
	GDIGW07D	ND	ND	ND	ND	9.2	ND		
	GDIGW08D	ND	ND	5.4	ND	ND	ND		
Arsenic (As)	GDIGW01D	ND	ND	ND	2.6	NT	NT	0.045	50
	GDIGW03D	ND	ND	ND	3.3	NT	NT		
	GDIGW04D	ND	ND	6	ND	NT	NT		
	GDIGW06D	ND	ND	3.5	ND	NT	NT		
	GDIGW07D	ND	5.2	ND	ND	7.4	2.2		
	GDIGW10D	ND	7.2	ND	ND	NT	NT		
	GDIGW11D	ND	ND	5.2	ND	NT	NT		
	GDIGW13D	ND	ND	6.5	ND	ND	2.4		
	GDIGW17D	ND	ND	ND	24.8	NT	NT		
	GDIGW19D	14.2	13.3	11.9	ND	NT	NT		
Barium (Ba)	GDIGW01D	35.7	27.7	ND	27.7	NT	NT	260	2000
	GDIGW02D	160	138	ND	136	NT	NT		
	GDIGW03D	ND	46.3	37.9	32.3	NT	NT		
	GDIGW04D	70.6	40.5	42.3	37.5	NT	NT		

Table 10.14.11
Grid-Based Wells
Analytes Detected in Deep Groundwater

Parameters	Location	1st Round	2nd Round	3rd Round	4th Round	5th Round	6th Round	Tap Water RBC*	MCL/SMCL*
Barium (Ba) (Continued)	GDIGW05D	44.6	32	ND	27.7	NT	NT		
	GDIGW06D	78.1	53.2	ND	54.3	NT	NT		
	GDIGW07D	144	115	ND	104	167	134		
	GDIGW08D	177	128	132	117	168	168		
	GDIGW09D	243	189	ND	190	NT	NT		
	GDIGW10D	129	60.7	ND	54.9	NT	NT		
	GDIGW11D	**368**	164	183	165	NT	NT		
	GDIGW12D	201	151	166	153	NT	NT		
	GDIGW13D	107	73.1	77.8	79.3	ND	98.7		
	GDIGW14D	**942**	**763**	**691**	**475**	NT	NT		
	GDIGW15D	46.9	43.3	48.1	45.2	NT	NT		
	GDIGW16D	68.3	50.3	54.6	48.4	NT	NT		
	GDIGW17D	133	118	126	160	NT	NT		
	GDIGW18D	**333**	254	75.9	249	NT	NT		
	GDIGW19D	60	82.3	ND	88	NT	NT		
Beryllium (Be)	GDIGW02D	ND	ND	0.9	ND	NT	NT	7.3	4
	GDIGW05D	ND	1.2	0.87	ND	NT	NT		
	GDIGW06D	ND	ND	0.83	ND	NT	NT		
	GDIGW07D	ND	1	ND	ND	ND	ND		
	GDIGW08D	ND	ND	1	ND	ND	ND		
	GDIGW09D	ND	1	ND	ND	ND	ND		
	GDIGW10D	ND	1.2	ND	ND	NT	NT		

Table 10.14.11
Grid-Based Wells
Analytes Detected in Deep Groundwater

Parameters	Location	1st Round	2nd Round	3rd Round	4th Round	5th Round	6th Round	Tap Water RBC*	MCL/SMCL*
Beryllium (Be) (Continued)	GDIGW13D	ND	1	ND	1	ND	ND		
	GDIGW14D	ND	1	ND	0.87	NT	NT		
	GDIGW16D	ND	1.1	ND	ND	NT	NT		
	GDIGW19D	ND	1	ND	ND	NT	NT		
Cadmium (Cd)	GDIGW05D	ND	ND	ND	2	NT	NT	1.8	5
	GDIGW07D	ND	ND	ND	ND	0.75	2		
	GDIGW08D	ND	ND	ND	ND	0.4	ND		
	GDIGW10D	0.3	ND	ND	ND	NT	NT		
	GDIGW13D	ND	2.5	ND	ND	ND	ND		
	GDIGW19D	0.3	ND	ND	ND	NT	NT		
Chromium (Cr) (total)	GDIGW01D	6.8	ND	ND	4.6	NT	NT	18	100
	GDIGW02D	NT	NT	1.8	ND	NT	NT		
	GDIGW03D	2.2	1.1	ND	ND	NT	NT		
	GDIGW04D	2.7	ND	ND	1.4	NT	NT		
	GDIGW06D	ND	ND	2.4	ND	NT	NT		
	GDIGW07D	2.4	1.2	ND	ND	ND	17.6		
	GDIGW08D	1.6	ND	ND	ND	ND	ND		
	GDIGW09D	1.7	ND	2.3	2.9	NT	NT		
	GDIGW10D	2	ND	ND	6.6	NT	NT		
	GDIGW11D	2.3	ND	3.7	ND	NT	NT		
	GDIGW12D	0.94	ND	5	ND	NT	NT		
	GDIGW13D	3.1	2	ND	ND	ND	49.5		

Table 10.14.11
Grid-Based Wells
Analytes Detected in Deep Groundwater

Parameters	Location	1st Round	2nd Round	3rd Round	4th Round	5th Round	6th Round	Tap Water RBC*	MCL/SMCL*
Chromium (Cr) (total) (Continued)	GDIGW14D	1.2	ND	ND	ND	NT	NT		
	GDIGW17D	ND	ND	ND	6.4	NT	NT		
	GDIGW18D	2.5	1.8	ND	6.7	NT	NT		
	GDIGW19D	2.2	ND	1.1	11.7	NT	NT		
Cobalt (Co)	GDIGW03D	ND	ND	2.3	ND	NT	NT	220	NL
	GDIGW04D	ND	ND	2.4	ND	NT	NT		
	GDIGW07D	ND	ND	ND	ND	3.6	ND		
	GDIGW08D	1.1	ND	ND	ND	ND	ND		
	GDIGW10D	0.87	ND	ND	ND	NT	NT		
	GDIGW11D	1	ND	ND	ND	NT	NT		
	GDIGW13D	0.76	ND	ND	ND	ND	ND		
	GDIGW14D	1.3	ND	ND	ND	NT	NT		
	GDIGW18D	0.66	ND	ND	ND	NT	NT		
Copper (Cu)	GDIGW02D	ND	ND	0.99	ND	NT	NT	150	1300
	GDIGW05D	0.82	ND	ND	ND	NT	NT		
	GDIGW06D	0.79	ND	ND	ND	NT	NT		
	GDIGW09D	ND	ND	4.3	ND	NT	NT		
	GDIGW15D	4.2	ND	ND	ND	NT	NT		
	GDIGW16D	1.8	ND	ND	ND	NT	NT		
	GDIGW17D	1.7	ND	ND	15.4	NT	NT		

Table 10.14.11
Grid-Based Wells
Analytes Detected in Deep Groundwater

Parameters	Location	1st Round	2nd Round	3rd Round	4th Round	5th Round	6th Round	Tap Water RBC*	MCL/SMCL*
Cyanide	GDIGW06D	ND	ND	6	ND	NT	NT	73	200
	GDIGW08D	ND	7.8	ND	ND	ND	ND		
	GDIGW09D	23.1	ND	ND	ND	NT	NT		
	GDIGW10D	27.2	ND	ND	ND	NT	NT		
	GDIGW13D	**329**	8.9	ND	ND	ND	ND		
	GDIGW15D	ND	16.6	ND	ND	NT	NT		
	GDIGW18D	30.2	12.9	ND	ND	NT	NT		
Lead (Pb)	GDIGW01D	2.9	ND	ND	ND	NT	NT	15	15
	GDIGW03D	2.2	8.9	ND	ND	NT	NT		
	GDIGW04D	3.2	ND	ND	ND	NT	NT		
	GDIGW05D	4.3	ND	ND	3.6	NT	NT		
	GDIGW10D	**26.2**	ND	ND	ND	NT	NT		
	GDIGW11D	ND	ND	ND	51.4	NT	NT		
	GDIGW19D	5.3	ND	ND	ND	NT	NT		
Manganese (Mn)	GDIGW01D	**151**	**130**	**134**	**144**	NT	NT	73	NL
	GDIGW02D	**198**	**232**	**249**	**261**	NT	NT		
	GDIGW03D	**247**	**261**	**202**	**174**	NT	NT		
	GDIGW04D	**160**	**123**	**126**	**116**	NT	NT		
	GDIGW05D	**152**	**98.1**	**98.3**	**95**	NT	NT		
	GDIGW06D	**302**	**253**	**244**	**237**	NT	NT		
	GDIGW07D	**112**	ND	ND	ND	ND	ND		
	GDIGW08D	65.6	11.8	3.3	0.99	ND	24.7		

Table 10.14.11
Grid-Based Wells
Analytes Detected in Deep Groundwater

Parameters	Location	1st Round	2nd Round	3rd Round	4th Round	5th Round	6th Round	Tap Water RBC*	MCL/SMCL*
Manganese (Mn) (Continued)	GDIGW09D	**243**	**184**	**161**	**186**	NT	NT		
	GDIGW10D	**173**	12.3	**690**	7.2	NT	NT		
	GDIGW11D	**218**	**173**	**181**	**184**	NT	NT		
	GDIGW12D	**127**	**84.3**	70.4	**84**	NT	NT		
	GDIGW13D	54.8	ND	ND	ND	ND	29.8		
	GDIGW14D	0.42	ND	ND	ND	NT	NT		
	GDIGW15D	**172**	**93.9**	**103**	**98.8**	NT	NT		
	GDIGW16D	**110**	59.1	59.3	56	NT	NT		
	GDIGW17D	14.5	ND	ND	ND	NT	NT		
	GDIGW18D	36.8	ND	ND	ND	NT	NT		
	GDIGW19D	72.7	57.8	45.8	40.5	NT	NT		
Mercury (Hg)	GDIGW09D	ND	0.3	ND	ND	NT	NT	1.1	2
	GDIGW10D	ND	0.21	ND	ND	NT	NT		
	GDIGW18D	ND	**1.9**	ND	ND	NT	NT		
Nickel (Ni)	GDIGW01D	3.9	ND	ND	2.8	NT	NT	73	100
	GDIGW02D	2	ND	0.95	0.99	NT	NT		
	GDIGW03D	2.3	ND	ND	ND	NT	NT		
	GDIGW04D	ND	ND	ND	0.87	NT	NT		
	GDIGW05D	**454**	ND	ND	ND	NT	NT		
	GDIGW06D	1.7	ND	ND	ND	NT	NT		
	GDIGW09D	ND	ND	ND	1.7	NT	NT		
	GDIGW10D	ND	ND	ND	4.8	NT	NT		

Table 10.14.11
Grid-Based Wells
Analytes Detected in Deep Groundwater

Parameters	Location	1st Round	2nd Round	3rd Round	4th Round	5th Round	6th Round	Tap Water RBC*	MCL/SMCL*
Nickel (Ni) (Continued)	GDIGW11D	4.2	2.2	3.8	ND	NT	NT		
	GDIGW14D	6.8	3.2	ND	ND	NT	NT		
	GDIGW15D	2.9	ND	ND	ND	NT	NT		
	GDIGW16D	1.4	ND	ND	ND	NT	NT		
	GDIGW17D	ND	ND	ND	10.1	NT	NT		
Selenium (Se)	GDIGW14D	ND	ND	ND	5.9	NT	NT	18	50
Thallium (Tl)	GDIGW01D	ND	5.1	ND	ND	NT	NT	0.26	2
	GDIGW02D	ND	ND	4.2	ND	NT	NT		
	GDIGW05D	ND	5.5	ND	ND	NT	NT		
	GDIGW07D	ND	5.6	ND	ND	ND	ND		
	GDIGW08D	ND	5.5	ND	ND	ND	ND		
	GDIGW09D	ND	6.9	ND	ND	NT	NT		
	GDIGW10D	ND	8.6	ND	3.1	NT	NT		
	GDIGW11D	ND	ND	ND	5.7	NT	NT		
	GDIGW12D	ND	5.6	ND	ND	NT	NT		
	GDIGW15D	ND	ND	7.1	ND	NT	NT		
	GDIGW17D	ND	6.3	ND	15.4	NT	NT		
	GDIGW18D	ND	5.2	5.2	6.1	NT	NT		
Tin (Sn)	GDIGW03D	365	ND	ND	ND	NT	NT	2200	NL
	GDIGW04D	319	ND	ND	ND	NT	NT		
	GDIGW07D	ND	ND	ND	ND	7	ND		
	GDIGW09D	218	ND	ND	ND	NT	NT		

Table 10.14.11
Grid-Based Wells
Analytes Detected in Deep Groundwater

Parameters	Location	1st Round	2nd Round	3rd Round	4th Round	5th Round	6th Round	Tap Water RBC*	MCL/SMCL*
Tin (Sn) (Continued)	GDIGW10D	ND	ND	ND	3.7	NT	NT		
	GDIGW11D	207	ND	ND	ND	NT	NT		
	GDIGW12D	347	ND	ND	ND	NT	NT		
	GDIGW14D	115	ND	ND	ND	NT	NT		
	GDIGW15D	ND	ND	ND	3.1	NT	NT		
	GDIGW18D	336	ND	ND	3.1	NT	NT		
Vanadium (V)	GDIGW02D	ND	ND	2.1	ND	NT	NT	26	NL
	GDIGW03D	4.8	2.4	8.4	12	NT	NT		
	GDIGW04D	3.6	10.6	15.7	18.7	NT	NT		
	GDIGW05D	ND	ND	0.95	ND	NT	NT		
	GDIGW06D	ND	2.8	4.4	7.2	NT	NT		
	GDIGW07D	1.4	1.5	ND	ND	ND	ND		
	GDIGW08D	ND	1.9	ND	ND	ND	ND		
	GDIGW10D	2.6	2	ND	5.3	NT	NT		
	GDIGW11D	5.6	6.1	6.6	6.4	NT	NT		
	GDIGW13D	4.6	8.6	ND	4.6	ND	14.8		
	GDIGW17D	ND	2.4	ND	ND	NT	NT		
	GDIGW18D	ND	3.2	ND	1.6	NT	NT		
	GDIGW19D	1.5	ND	ND	1.4	NT	NT		

Table 10.14.11
Grid-Based Wells
Analytes Detected in Deep Groundwater

Parameters	Location	1st Round	2nd Round	3rd Round	4th Round	5th Round	6th Round	Tap Water RBC*	MCL/SMCL*
Zinc (Zn)	GDIGW01D	12.4	ND	ND	ND	NT	NT	1100	NL
	GDIGW02D	9	ND	ND	ND	NT	NT		
	GDIGW03D	22.3	ND	ND	ND	NT	NT		
	GDIGW05D	20.5	ND	ND	ND	NT	NT		
	GDIGW06D	6.95	ND	ND	ND	NT	NT		
	GDIGW09D	18	ND	ND	ND	NT	NT		
	GDIGW11D	9.7	ND	ND	ND	NT	NT		
	GDIGW12D	22.1	ND	ND	ND	NT	NT		
	GDIGW14D	18.3	ND	ND	ND	NT	NT		
	GDIGW15D	116	ND	ND	ND	NT	NT		
	GDIGW16D	9.1	ND	ND	ND	NT	NT		
	GDIGW17D	12.3	ND	ND	ND	NT	NT		
	GDIGW18D	65.7	ND	ND	ND	NT	NT		

Notes:
* = Tap Water RBCs (THQ=0.1) from *Risk-Based Concentration Table* (USEPA, October 22, 1997), and MCLs/SMCLs from *Drinking Water Regulations and Health Advisories* (USEPA, 1996e)
Bolded concentrations exceed the RBC or SSL
NA = Not applicable/not available
ND = Not detected
NI = Not installed
NL = Not listed
NT = Not taken
RBC = Risk-based concentration
SSL = Soil screening level
ng/kg = Nanograms per kilogram
μg/kg = Micrograms per kilogram
pg/l = Picograms per liter
μg/l = Micrograms per liter
mg/kg = Milligrams per kilogram
mg/l = Milligrams per liter

Organic Compounds in Groundwater

Fifteen VOCs were detected in grid-based shallow groundwater samples and eight in deep groundwater samples.

Semivolatile Organic Compounds in Groundwater

Nineteen SVOCs were detected in grid-based shallow groundwater samples and nine SVOCs in deep groundwater samples.

Pesticides and PCBs in Groundwater

Nine pesticides were detected in grid-based shallow groundwater samples and six pesticides in deep groundwater samples. Pesticides were detected in only one round of sampling in both the shallow and deep samples and were not duplicated in subsequent sampling rounds.

Aroclor-1260 was detected in the first round from one sample in both the shallow and deep groundwater. There were no other detections of PCBs in the grid-based wells.

Herbicides

There were two detections in the grid-based shallow groundwater samples from the first round. The detections were not seen in subsequent rounds. There were also two herebicides detected in the deep groundwater samples in the first round. Again, these were not detected in subsequent rounds.

Other Organic Compounds in Groundwater

TEQs were calculated for both shallow and deep groundwater samples. All calculated TEQs were well below RBCs.

Inorganics in Groundwater

Twenty metals were detected in grid-based shallow groundwater samples. These detections were used to calculate shallow groundwater background values for Zone I. Nineteen metals were detected in grid-based deep groundwater samples. These detections were used to calculate deep background values for Zone I.

10.14.5 DPT Samples in Groundwater

As a result of VOC detections in grid-based well GDI011, five DPT groundwater samples were collected around this well point. The DPT sample locations are shown on Figure 1.3 (Section 1). The five DPT groundwater samples were analyzed for VOCs only. Only three VOCs were detected in the DPT groundwater samples: methylene chloride (8.0 μg/L) in GDIGP002 and acetone (4.0 μg/L) and carbon disulfide (1.0 μg/L) in GDIGP005. The results of the DPT sampling did not confirm the presence of a contaminant plume in the area of GDI011/11D, but rather indicate that the detections seen in GDI011 are a hot-spot or a sample anomaly.